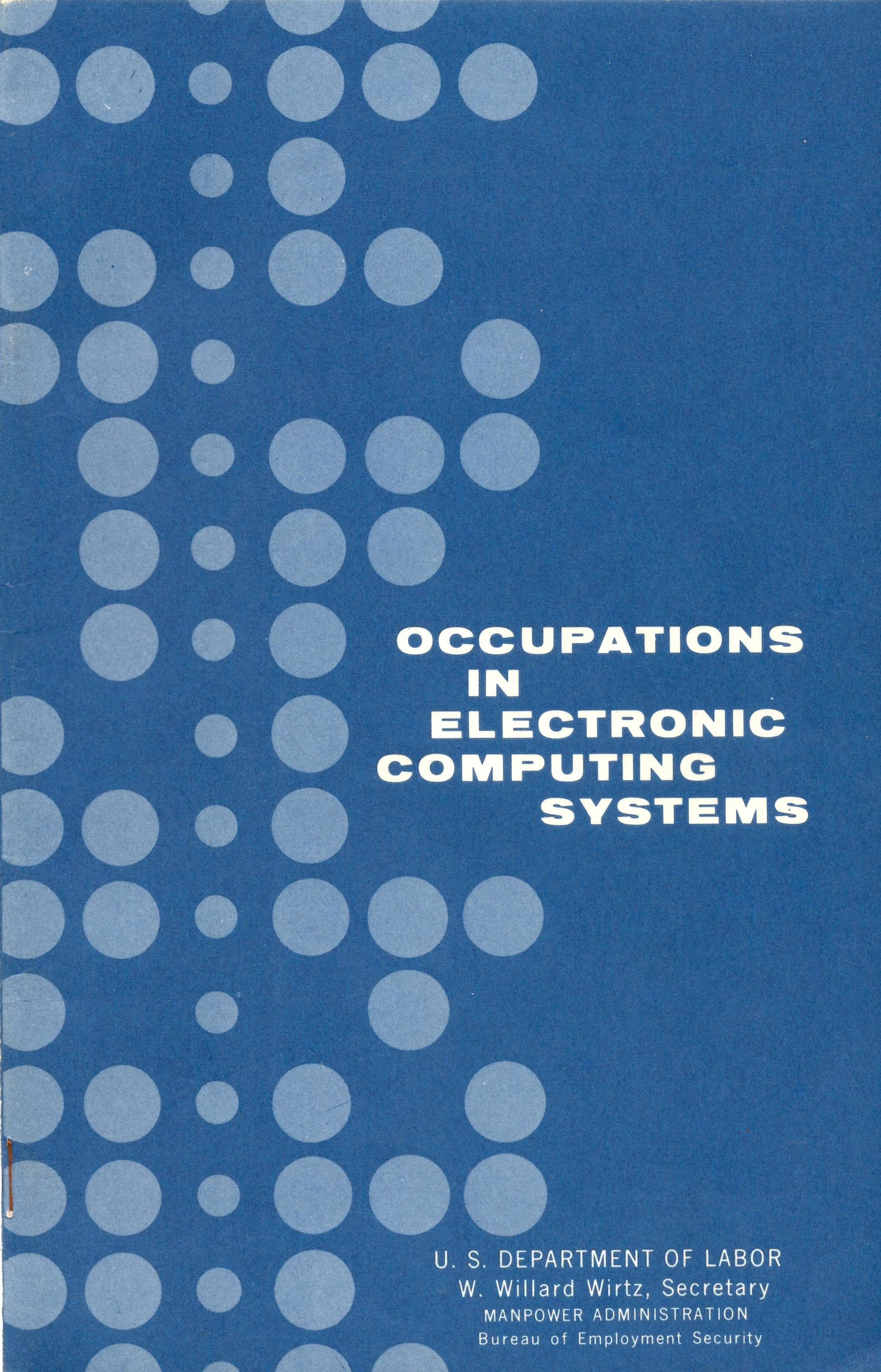
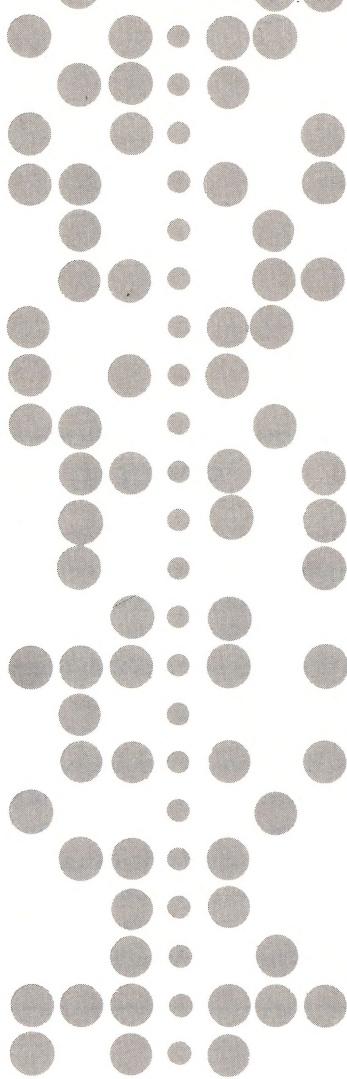




OCCUPATIONS IN ELECTRONIC COMPUTING SYSTEMS

U. S. DEPARTMENT OF LABOR
W. Willard Wirtz, Secretary
MANPOWER ADMINISTRATION
Bureau of Employment Security



OCCUPATIONS IN ELECTRONIC COMPUTING SYSTEMS

BUREAU OF EMPLOYMENT SECURITY
Robert C. Goodwin, Administrator

U. S. EMPLOYMENT SERVICE

1965



SPECIAL NOTICE

The occupational descriptions contained in this volume have been compiled from a number of different sources and therefore describe the individual occupations in a generalized composite form. Consequently, no description can be expected to coincide exactly with any specific job in a particular establishment or in a particular locality. To be of greatest usefulness, the descriptions should be supplemented by local information concerning the specific jobs in the community.

The U.S. Employment Service has no responsibility for the settling of jurisdictional matters or the setting of wages and hours. In the preparation of occupational descriptions, no facts concerning such matters were collected. It should be clearly understood, therefore, that because of their nature, occupational descriptions published by the U.S. Employment Service cannot be considered standards for the determination of wages, hours, or jurisdictional matters.

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FOREWORD

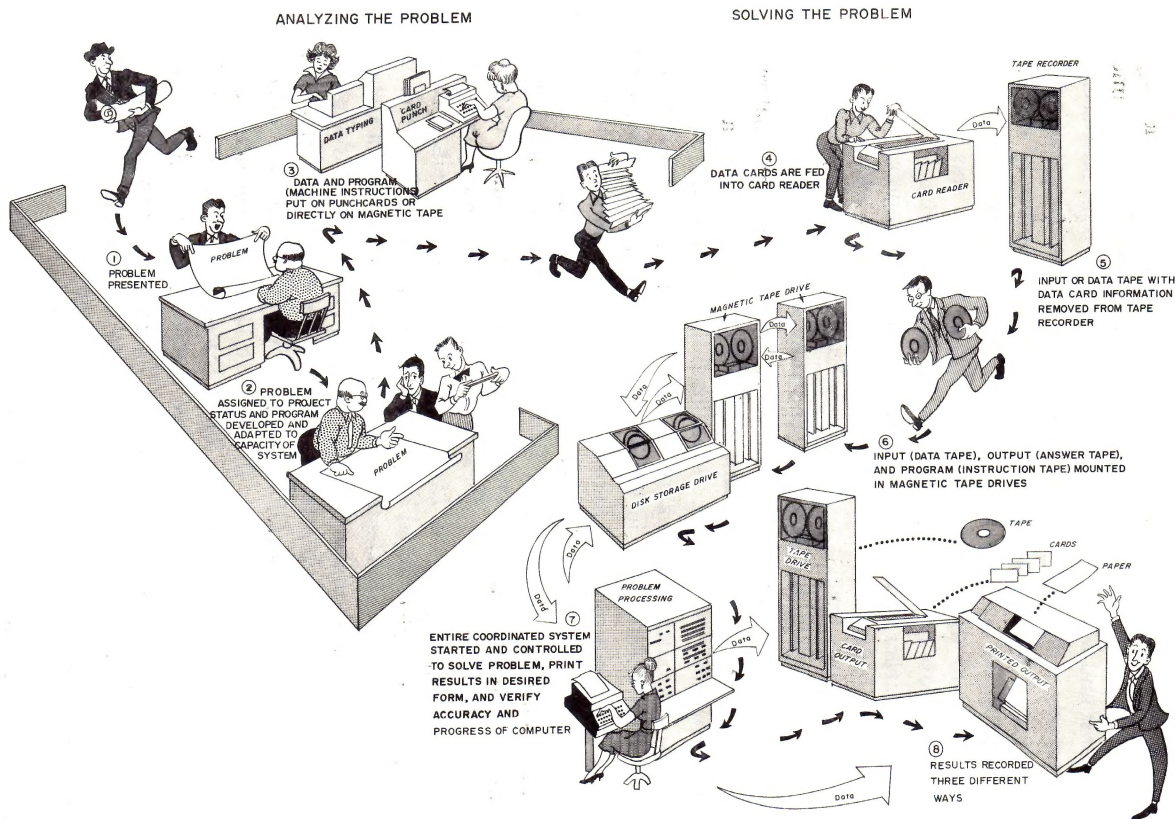
This brochure is essentially an updating of *OCCUPATIONS IN ELECTRONIC DATA-PROCESSING SYSTEMS*, published in 1959. The original booklet saw considerable use and wide distribution; and when another reprinting became necessary recently, a review indicated that equipment, processing, and operations had changed sufficiently to warrant a complete resurvey of this area of activity. Also, so much has been written about data processing since 1959, that much of the bibliographical reference material was either no longer fully accurate or had been replaced by newer material. This revision, as was the earlier edition, is designed to present occupational information for use in the placement and counseling services of the affiliated State Employment Services. This information also will be useful to others concerned with recruitment, training, and counseling of persons in this field of work.

Contributions to this revision came from many sources. Job analyses provided the primary source data. Additional information and data were obtained from periodicals, publications listed in the bibliography, and from many discussions with experts in various phases of electronic computing. Most of the basic work on this revision, including the job analyses and drafts of the job descriptions and narrative materials, was performed by Joseph Alexander and Harry Sherfinski, occupational analysts of the Wisconsin State Employment Service's Occupational Analysis Field Center, under the supervision of George A. Kaisler, Field Center Supervisor. Final preparation, under the broad direction of Leon Lewis, Chief of the Branch of Occupational Analysis, was performed by Stanley N. Foged and E. R. Lee of the Occupational Analysis Field Center of the USES for the District of Columbia, and John L. Welch, under the supervision of Walter S. Studdiford.

Grateful acknowledgment is extended to personnel of the Data Processing Division of the Comptroller's Office, City of Milwaukee, Wis.; the Data Processing Division of Milwaukee, the County Court House, Milwaukee, Wis.; the Milwaukee Chapter of the Data Processing Management Association, Milwaukee, Wis.; the Milwaukee Institute of Technology, Milwaukee, Wis.; Giddings and Lewis Machine Tool Co., Fond du Lac, Wis.; A. O. Smith Corp., Milwaukee, Wis.; the Cudahy Division of the George J. Meyer Manufacturing Co., Cudahy, Wis.; Milwaukee Gas Light Co., and other sources in the State of Wisconsin.

Also, the Research and Computation Division of Electronic Associates, Inc., Rockville, Md.; International Business Machines Corp.; Burroughs Corp.; Digital Equipment Corp., Washington, D.C.; Radio Corporation of America; UNIVAC Division, Sperry Rand Corp.; General Electric Co.; Motion Analysis Section, Stability and Control Division, David Taylor Model Basin, U.S. Navy; Research and Advisory Committee, Data Processing Management Association, Worcester, Mass.; and many other sources.

TYPICAL COMPUTER CONFIGURATION



INTRODUCTION

Historical Background and Current Status

To most people the words “computer,” “data-processing systems,” and “electronic brain” are strange and magical symbols of perhaps one of the most heralded and most feared technological revolutions in our lifetime. Their blinking lights, whirring reels, and clicking relays are changing centuries-old ways of doing business. They are speeding up the solving of the remaining riddles of science; they are creating new jobs and even whole new industries; and many people are fearful that they will swell the rolls of the unemployed by rendering obsolete the livelihoods of many thousands of workers.

The “brains” make airline reservations for thousands of passengers on hundreds of planes from dozens of cities—in hundredths of a second. They scan tax returns to detect errors and fraud. They post bank deposits, take inventory, flash stock quotations, read gas meters, bill customers, write checks, rate insurance risks, record traffic violations, predict election results, solve equations, test submarines, guide missiles, make up trains, diagnose diseases, play bridge, and regulate the operations of a thousand-acre refinery.

Yet, without human minds and hands to conceive, build, install, maintain, program, and interpret them, these “brains” can do nothing. The 23 occupations described on the following pages are not the only occupations to be affected by the data-processing revolution, but these occupations could not exist had it not occurred.

An important segment of the economy affected by industrial change was business office activity. Here the typewriter and other office machines became an integral and familiar part of the American scene. Manually operated, these machines met the business needs at the turn of the century, but as the economy grew, the need to increase the quality and speed of output intensified. To satisfy this need, electromechanical data processing was developed. This method comprises a series of machines, such as sorters, collators, verifiers, and tabulators, to form a complete system for the processing of data. Workers operate each machine independently within the system, feeding punched cards into it in sequence to obtain a desired data output. While this is a vast improvement over manual methods, it is now considered too slow to meet present-day paperwork demands.

The punchcard method was not new when it was applied to electromechanical machines. It was introduced in 1801 by Joseph M. Jacquard, a Frenchman, who devised a loom in which the weaving of textiles was auto-

matically performed according to a punched-hole pattern. The same principle was applied to the player piano. In this device, rolls of punched paper mechanically activate the keyboard according to the pattern of punched holes in the roll.

Electromechanical data processing was born during the 1880's when the U.S. Bureau of the Census discovered that results of the 1880 census required nine years to compute. Considering the anticipated rise in population, from 50 million to more than 60 million, it was estimated that the 1890 census would not be completed until after the 1900 census count was taken. Confronted with this situation, Herman Hollerith, an employee of the Census Bureau, applied the punched-hole principle to cards and sorted them mechanically. Holes punched in various places on a card represented individual items of information. These cards were fed into a machine that tabulated them by means of electrical contacts made through the punched holes. With this innovation, census data for 62 million persons were tabulated in two years.

The electromechanical machine method still is used extensively by Government and business to maintain and record data concerned with inventories, sales, and similar records. The printing capabilities of machines produced in recent years have made them more useful for such applications as customer billing and report production.

However, the electromechanical machines have inherent limitations. Operating runs must be set up on a serialized "batch process" basis. There are limits to the extent that functions can be combined by machine interconnection. Calculating speed usually is limited by the switching speeds of electromechanical relays, of mechanical linkages, and by the need for punchcard manipulation and sensing during operating runs. Most important of all, the relative lack of flexibility imposed by wired plugboard control of these machines tends to restrict their use.

Currently available electronic data-processing equipment will not eliminate the need for these machines. They can perform some functions at less cost than many computers. Also, many electromechanical machines will continue to be used as auxiliary, "off-line" equipment, providing services essential to the economical operation of punchcard-oriented computer systems.

The "first generation" of general purpose, stored-program digital computers was delivered to their users barely 13 years ago. They were not "magic brains." They were sophisticated machines that had to be programmed, by men, for every step of their operations. Compared with later computers, these machines were ungainly, overweight, somewhat inflexible, often unruly, and very demanding in their requirements for air conditioning.

These computers did have two great advantages over previously available electromechanical equipment. One, the use of vacuum tubes for switching, released the computer from the speed limitations of electromechanical devices. The other advantage, of crucial significance, was that these were

the first practical machines to be internally programmable. That is, they were designed to operate from instructions stored in the computer, instead of from instructions imposed externally by such means as a wired control panel. Internal programing permits the computer to make large numbers of mathematical comparisons and consequent "logical decisions" that modify the course of action during computation. It is the reason computers seem to "think."

"Second generation" digital computers made extensive use of such developments in solid-state physics as the transistor, which virtually replaced the vacuum tube. As a result, the physical size of computer systems was reduced dramatically. Calculating speeds continued to increase, with many medium-to-large-scale systems capable of performing computations in microseconds (millionths of a second). Small desk-size computers were made available with the flexibility, if not the speed, of larger equipment. Air conditioning became less important, but usually was specified to protect the circuitry from dust and possible heat buildup. Modular or "building block" concepts were applied to the design of internal circuitry and to the design of other major pieces of hardware in the computer system to permit easy expansion of the system when new processing demands had to be met. Improvements in peripheral equipment, such as increasing the printing speed of output devices, permitted their use on-line, directly interconnected with the computer, without unduly reducing the overall speed of the system. Built-in error detection and correction devices reduced the need for operator intervention, as did improved software, or programing techniques.

While the line of demarcation for "third generation" computers is not so obvious as that between the first two generations, it is characterized by changed management information requirements, increased systems and programing sophistication, and greater miniaturization of equipment. Increased use of random access storage devices, such as disk and drum memory units, allow virtually all the operating experience of an organization to be stored, and to be retrieved almost immediately. Data-recording devices can be installed to capture information in "one writing" at the point and time of origin, in a form the computer can process. Data communications equipment is available to route data directly to computer storage, to link computers with other computers, and to permit interrogation of, and recording of responses from, the computer system at remote operating consoles. Optical scanners and magnetic ink character recognition and sorting equipment already are in use in insurance, utility, and banking applications. Some "third generation" computers even offer nanosecond (billionths of a second) speeds.

Digital computers have been marketed that are capable of parallel-processing (processing several programs simultaneously) and of operating in so-called "real time" to control factors external to the computer system, such as an industrial process. "Operator" instructions have been incorporated into computer programs to effect automatic transfer from one program or series

of programs to the next. Under constant development are automatic programming and coding techniques and common programming “languages” to simplify the preparation of computer instructions.

Originally confined to mammoth corporations and Federal and State governments, digital computers—and the men and women who work with them—are now found throughout small business, industry, and municipal government, colleges and universities, nonprofit research laboratories, trade and professional groups, fraternal organizations, and many other places where their cost can be more than offset by their savings. A network of data-processing centers now dots the map, providing computer rental time to anyone with a problem to solve but without the need or resources to buy or lease one on a full-time basis. Office equipment and supply firms and manufacturers of such items as cash registers and time recorders are designing their wares with an eye to eventual use with computers. Veterans of the first- and second-generation computer revolution confidently await the day when some kind of data-processing system will be as commonplace in the one-man office or retail store as the telephone is today. And who knows, perhaps even a model for home use will be economically feasible within the next decade.

Present and Future Implications

Management is rapidly becoming aware of the value of computer systems, not just as a big tabulating machine, but as the basis for key decisions in management analysis, communication control, and long-range planning. In turn, this has had other effects that have only recently become obvious. Computer-oriented organizations are being forced to realine themselves and their functions according to the kinds of data generated and required. Centralization of information gathering, processing, and analysis is becoming common. Experts in electronic data processing now are being drawn from their areas of specialization into higher level “mainstream” management to provide improved control over electronic-data-processing operations and planning, and to enhance top management’s understanding of computer potentialities.

Electronic data processing has opened new fields of employment, creating new jobs and modifying the skill requirements of existing ones. In many instances, it has been possible for employers to reassign their employees to other jobs when they faced displacement. In other instances, employers have been able to retrain many employees in the new systems and procedures resulting from the applications of computers, particularly those in clerical, electrical accounting machine, statistical, accounting, and supply occupations. There has been a fairly widespread body of opinion that electronic computers, and particularly data-processing equipment, will create considerable unemployment, especially among lesser skilled workers. Experience, at least to date, has not borne out these predictions, and there is a rising feeling that the impact of this area of technological development

on unemployment may not be as serious as at first feared. However, retraining and reassignment may become more difficult in the future as computer applications increase productivity; more positions performing routine work manually will become expendable thus reducing opportunities for reassignment to work requiring little training. We can be certain that changes in personnel needs and in job requirements and techniques will be a continuing aspect of technological advance.

Our educational system is cognizant of the academic and technical training needs of the computer age. At the post-high school level, some junior colleges and schools of vocational and adult education are offering 2-year data-processing courses. Engineering schools and schools of business administration are beginning to include basic computer orientation courses in their curricula. Many technical schools have begun to offer fairly extensive training in computer repair to electronics technicians, some of them by correspondence courses.

The Analog

Less familiar, but scarcely less important, is the analog computer—which differs from its digital counterpart in several basic respects. Essentially, the analog solves problems in the form of an analogy—by expressing the problem in the form of a “mathematical model” or equation that can be changed as necessary while the computer is at work. For example, stresses on a missile or submarine are constantly changing as the missile rises or as the submarine descends. By changing control settings to reflect these changes, the analog computer gives a continuing answer to a constantly changing “problem,” while the digital computer must be separately programmed for each variable. Since the variables may not be known until the analog determines them, the usefulness of each computer is enhanced by application of both to the same problem in these areas.

Electronic analog computers, made possible by the development of electronic amplifiers employing Lee De Forest’s electronic tube, appeared during World War II. These ingenious devices were applied to problems of weapons design, military tactics, aircraft navigation, and similar applications where conventional planning and testing procedures were either impractical or too time-consuming. By simulating actual combat conditions or operational conditions in the laboratory, analog computers undoubtedly speeded the development of military technology, saved many American lives, and perhaps even shortened the war by months.

Development of the electronic chopper stabilizer to minimize drift in the amplifier tuning circuits greatly increased the accuracy of analog computers, and broadened the use of d.c. amplifier circuitry. Increasingly sophisticated circuitry, transistors, solid-state components, and miniaturization, have today made possible the extension of analog computers to many areas of science and engineering.

As more and more analog computers are installed throughout industry and government, a number of analog computer service centers have been set up to serve users lacking their own computers. In some installations, analog and digital computers are coupled by conversion units to make up so-called hybrid systems, dramatically expanding the computer potential for solving super-complex problems. At present, such hybrid installations are restricted to special-purpose types of computers and are still considered in the experimental stage. Usually such hybrids are basically an analog computer with built-in digital units that control or program specific problems for repetitive solutions. The logic elements of the digital component usually are used for this purpose. In some cases, it is possible for the digital components to perform multiplications or other operations requiring greater accuracy than is possible with the analog computer alone. In these instances, however, the problem of programing the digital computer so that each solution is completed when needed by the analog is very critical. Poor timing here might result in greater inaccuracy than would be the case if a purely analog system were used.

The occupational situation in the analog field is unsettled. Rapid developments in equipment and new demands for analog-type computation preclude a set pattern of staffing. As contrasted with the digital computer system, which often has a veritable crew of workers, the analog uses one or two persons per problem to perform all operations from problem analysis to computer operation. Engineers and scientists, for example, frequently use desk analog computers in solving problems in their day-to-day work. With the establishment of analog computer service centers, a new type of professional worker is emerging. This person usually is an engineer or scientist with interest, training, and experience in mathematics through advanced calculus and differential equations. He has become skilled in applying his knowledge and experience to solving problems, using the huge, complex analog computers and peripheral equipment found in the service centers.

In large service centers, where 50 or more professionals may be employed, he usually specializes in problems related only to his background and discipline. However, in small centers, where perhaps only 5 or 10 professionals may be employed, each is expected to handle any problem assigned. Professionals in any size service center may work individually to carry out the solution of a problem, or they may work as members of a team. The only professional analog occupation described in this brochure is that of Applications Engineer (p. 15), the occupation occurring in the service centers. It describes the tasks involved in the solution of a problem from its inception. It is believed that as the analog computing field expands, a staffing pattern will become evident and additional occupations will be found in sufficient numbers in various locations to warrant analysis and description.

Arrangement of Publication

The 23 occupations described in this brochure are considered to be the basic occupations most directly concerned with electronic computing. The occupations, however, are still fluid. Hiring requirements and qualifications for employment have not yet been fully standardized. As a consequence, a certain amount of overlap and duplication of job duties and responsibilities will be noted among the various occupational descriptions. The occupational data, however, were assembled from many different sources and are a reflection of the existing situation. Since the data reflect the occupational situation as it exists in varied localities and establishments, the descriptions must be considered as composites of jobs, and cannot be expected to coincide exactly with any job in a specific organization. It will be necessary, therefore, to adapt descriptions to fit individual jobs before they can be used with complete accuracy. For that reason, it is also important that the user of this material be familiar with the purposes and meanings of the various sections included in this brochure and of the several parts of the individual occupational descriptions.

A number of sections are presented in the publication for the reader's use and guidance. A Functional Organization Chart of the Digital Electronic-Data-Processing System precedes the individual job descriptions. Its purpose is to permit relating the individual descriptions to the total computer installation.

Following the occupational descriptions is a glossary of technical terms. Although the glossary is by no means exhaustive, it is in sufficient detail to provide an understanding of those terms used in the occupational descriptions.

The next section is a presentation of worker trait components. A brief definition of factors which comprise each component is provided.

A selected bibliography follows the worker traits section. Many of the references listed were used in the present study. They are sufficiently diverse to provide a general knowledge of the technical aspects of the field.

After the bibliography is a list of organizations and educational institutions for those who may be interested in supplementing the information contained in this brochure and in the bibliographical references.

The last section of the brochure is the index of occupational titles. This list provides a ready reference for the location of any occupational description by the many common titles used in electronic data-processing installations.

The data made available here will provide a useful tool to those concerned with placement, counseling, and training in these relatively new and changing occupations.

Arrangement and Content of Occupational Descriptions

The job descriptions are arranged in alphabetical order of their main titles. The wording of the title that appears at the head of each description

is a reflection of common usage. Other titles, or alternate titles, by which the job is known, also appear at the head of each description in small type. Between the main and alternate titles appears first the code number which identifies the job within the present classification structure of the second edition of the *DICTIONARY OF OCCUPATIONAL TITLES*, published in 1949. Immediately following this code, there appears, in parentheses, a second code number. This is the occupational code contained in the third edition of the Dictionary being released in 1965. Until this edition is published and released to local employment offices of the State Employment Services and other government and private agencies and groups, this code number will have no meaning outside the context of the completely revised classification structure, and will serve no purpose. So it should not be used until then. It is presented here only to save time and prevent inconvenience in converting from the present code to the new one when that time arrives.

The narrative portion of each job description is arranged as follows:

Occupational Definition.—This provides a brief description of the duties involved in a particular occupation. It provides an understanding of the tasks that are performed, and the skills and knowledge that are necessary to the performance of those tasks.

Education, Training, and Experience.—This section provides an indication of the amount of education and the level of training and experience usually required by management for employment in the occupation. As previously mentioned, the various occupations and the qualifications are not standardized, and considerable variation exists among employers as to required education, training, and experience. However, an attempt was made to indicate the range of such hiring requirements.

Special Characteristics.—This section provides some estimate of the worker trait requirements pertinent to the specific occupations. It has long been believed that the ability of an individual to adjust to specific types of work situations is as significant as the education and training qualifications he brings to the occupation. This seems particularly significant when dealing with a group of relatively new occupations. Consequently, judgments have been in terms of a number of components consisting of aptitudes, interests, temperaments, physical activities, and environmental conditions to which individual workers have to adjust. A listing and definition of each factor for the various components is contained in the worker traits section.

Aptitudes.—These are the specific capacities or abilities required of an individual in order to facilitate the learning of some task or duty. This component is made up of 11 specific aptitude factors, and is a modification of the aptitudes contained in the General Aptitude Test Battery developed in the U.S. Employment Service. Those aptitudes were selected which seem to be significant in the occupation and were identified in terms of specific work situations. The factor of intelligence, however, was not rated because of the difficulty in writing meaningful descriptive statements.

Interests.—This component is defined as a preference for a particular type of work experience. It consists of five pairs of bipolar factors, arranged so that a preference for one factor in a pair generally indicates a lack of interest in the other factor in the pair. Those factors were identified which seemed to be significant to the job in question, and were identified in terms of specific worker situations.

Temperaments.—The temperament component consists of 12 factors defined in terms of specific work situations that suggest different temperament trait requirements. Each work situation describes a type of activity that demands a different adjustment on the part of individual workers. Those temperament factors were selected that appeared to be significant in the occupation, and were identified in terms of specific work duties.

Physical Activities and Environmental Conditions.—This refers to (a) the physical activities required to be met by the worker; and (b) the physical surroundings which make specific demands upon a worker's physical capacities. There are six physical activities factors and seven environmental conditions factors. Those factors were selected that were significant in the occupation in the sense that they met established criteria for successful performance.

DIGITAL WORK-FLOW PROCESS

Although variations exist in organization structures and functional activities, the many operations and steps involved can be systematized. Such factors as size of organization, amount and type of data to be processed, and the relationship of the data to the needs of the organization determine the makeup of the department as finally established, as well as the personnel required for its operation.

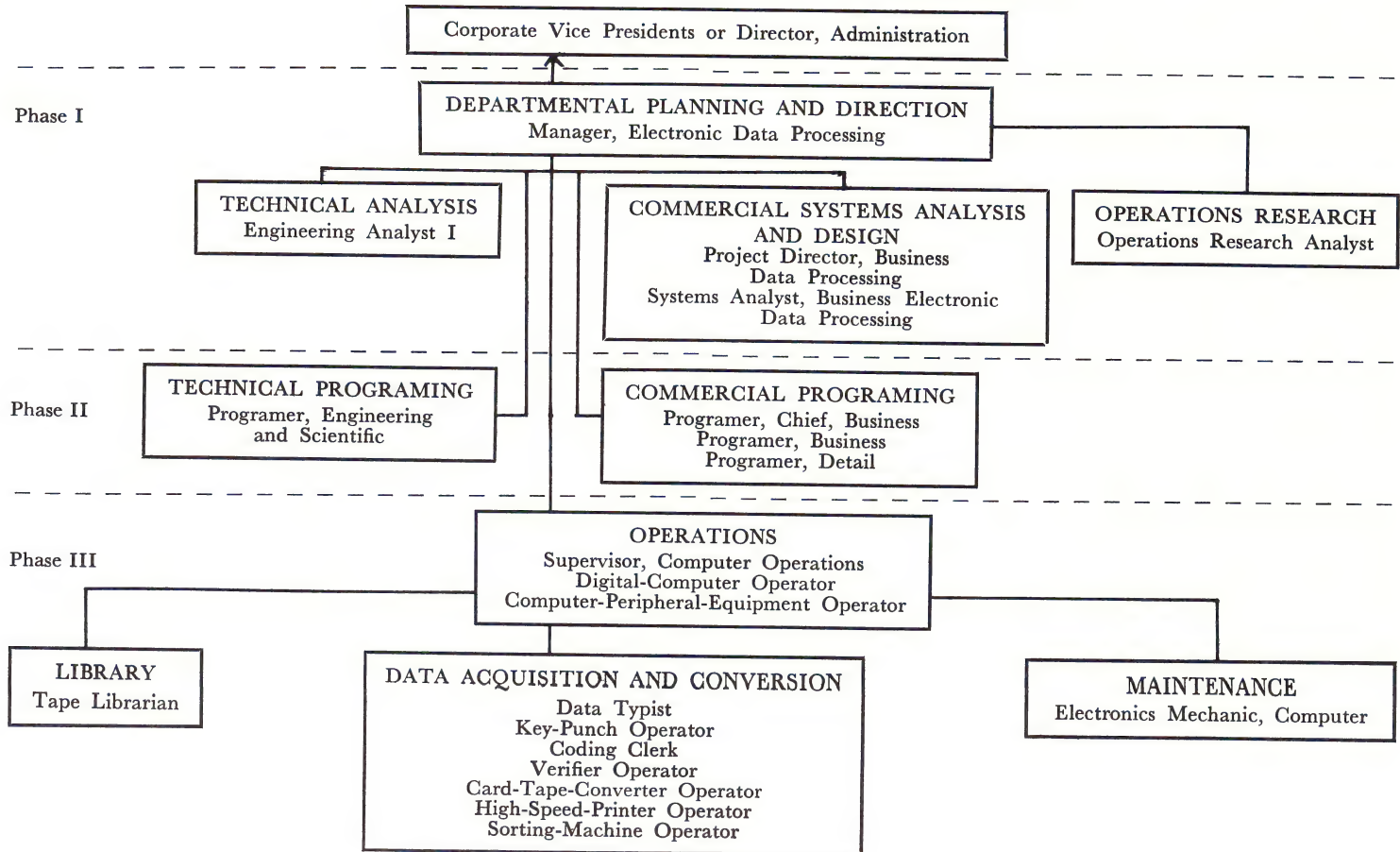
Phases in Processing Data

The functional organization chart reflects the typical steps involved in processing data. It is based on a sequence of three phases, namely, planning and analysis, problem programing, and operations, which includes data conversion (often found in units other than the data-processing department).

Phase I: Problem Planning, Formulation, and Systems Analysis

This phase is concerned with the overall planning, scheduling, and coordination of activities to achieve the desired results. By analyzing the data and the problem, a determination is made of the cost, machine capability, man- and machine-hours required, and whether processing can be performed electronically, mechanically, manually, or by a combination of such methods. Programers frequently participate in a discussion of machine capabilities. The preparation of work-flow plans and procedures establishes the processing sequence.

FUNCTIONAL ORGANIZATION CHART DIGITAL ELECTRONIC-DATA-PROCESSING SYSTEM



At this point, decisions are made pertaining to enlarging or altering the computer system to meet adequately the organization's processing needs. Budget estimates are prepared to justify the cost of processing operations and equipment.

Problem Formulation

The problem that has been developed is formulated more specifically and further refined at this stage. A mathematical or statistical analysis and statement of the problem is developed when it is required. Mathematical procedures are devised, and illustrative charts, tables, and diagrams prepared.

Systems Analysis and Systems Design

Systems analysis is the phase concerned with the determination of the data-processing needs of an organization. Systems analysis is the factfinding phase of system design and is a methodical, systematic study of the administration and operation of the organization. In this phase every fact pertaining to the operation of the organization is collected, organized, and evaluated. The rigorous review of all the facts and findings developed in the systems analysis phase is translated into an ideal plan or design of a data-processing system. The design devises or determines the most efficient methods and techniques for implementation, including detailed process flow charts or diagrams. The specific computer system requirements are worked out at this stage, usually in collaboration with high-level programmers.

Phase II: Programing

Programing translates the ideas and language of human beings developed in the systems analysis and systems design phase into the language of equipment. Such a language, which is a predetermined coding system, provides the equipment with the means for executing and controlling all the steps required in problem solution. Programing also involves analysis of equipment capabilities and limitations in order to break up the problem into successive runs whenever required and to establish a machine configuration.

Phase III: Operations

The operating phase is concerned with the actual data-processing machine operations that are involved in solving a problem and in obtaining the solution. In many installations all necessary data are transferred directly onto magnetic tape from punchcards or paper tape, and the various data tapes and program instructions are mounted in the pertinent tape units. The system is then put into operation and carefully controlled during each step of the total process. Final results are recorded on printout forms, tapes, cards, or microfilm depending on the needs of the organization.

DIGITAL-COMPUTER SYSTEM



Courtesy Radio Corporation of America

RELATED SERVICES

Library

A collection of tapes, cards, and forms is maintained from which selections are made when revising or setting up a program, or from which designated materials are withdrawn when certain programs are put into operation.

Maintenance

Since uninterrupted production is of foremost importance, the machine system must be maintained in maximum operating condition. The primary function of maintenance is to prevent machine breakdowns and malfunctions. Preventive maintenance routines are integrated with normal operations to permit uninterrupted processing of data.

OCCUPATIONAL DESCRIPTIONS

APPLICATIONS ENGINEER

**0-35.72
(020.081)**

computer engineer

Occupational Definition

Formulates mathematical models of systems, and sets up and controls analog computer to solve scientific and engineering problems: Consults with originator of problem to ascertain sources of data, methods of collecting data, and methods of determining values of variables, or examines and studies physical models or graphic representations and consults verbal descriptions of problem to apply knowledge of scientific discipline and define problem. Prepares mathematical model of problem applying principles of calculus and differential equations. Draws data-flow chart to indicate mathematical steps required for solution of problem. Computes voltage and time scales to convert mathematical equation into computer equation to ascertain potentiometer settings. Draws computer-circuit diagrams to indicate connections between components and their values. Wires patchboard to computer. Sets potentiometers according to circuit diagram or inserts tape into digital control unit that automatically sets potentiometers. Presses reset buttons to verify voltages of amplifiers. Controls computer to vary parameters in equations and simulate variables in the system. Observes behavior of variables on one or more output devices, such as plotters, recorders, digital voltmeter, printed readout, or oscilloscope. Prepares technical report describing, step-by-step, solution of problem. Develops new techniques for solving problems. Prepares articles for publication in scientific journals.

Education, Training, and Experience

College degree in engineering or physical or medical science with firm background in mathematics. At present time, engineers and physicists dominate the field. It is necessary to continue education on a part-time basis to keep informed of rapid changes and techniques in field of specialty, in developments in mathematics, and new equipment.

Special Characteristics

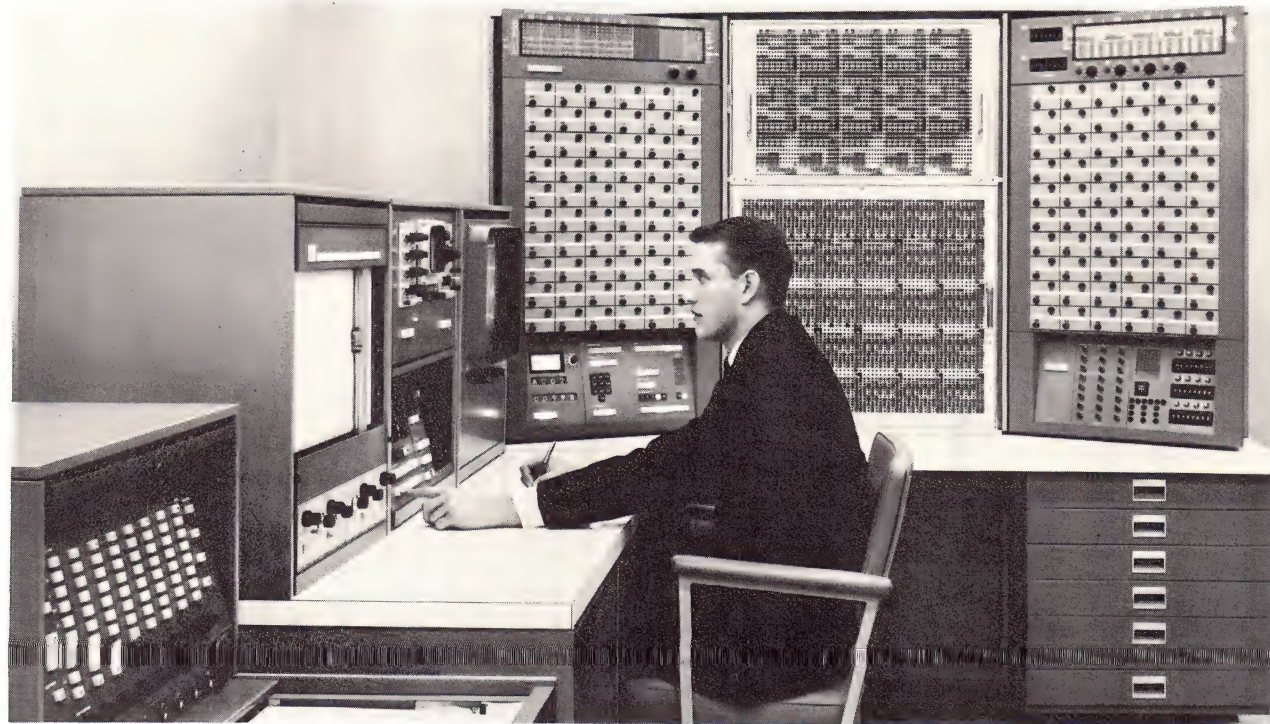
Aptitudes:

Verbal ability to understand technical data and discuss problems with project originators, and to prepare reports of findings.

Numerical ability to analyze problems, to apply pertinent mathematical disciplines and to prepare mathematical formulation of physical problems under study.

Spatial ability to perceive form of objects as portrayed on blueprints, drawings, and mathematical formulations, and to formulate problems.

ANALOG COMPUTER



Courtesy Electronic Associates, Inc.

Form perception to recognize forms and shapes used to draw computer circuit diagrams.

Clerical perception to detect or avoid making perceptual errors in working with pages of mathematical equations.

Interests:

A preference for activities that are technical in nature to apply analytical and experimental methods to solve problems concerning physical systems.

Interest in devising mathematical equations, analyzing the methods used for their manipulations, and evaluating their practical effectiveness.

Temperaments:

Ability to perform a variety of activities such as problem analysis, mathematical formulation, meeting with clients, and report preparation.

Required to make decisions on a judgmental basis when assessing mathematical formulations, and devising procedures.

Required to make decisions on basis of verifiable data, such as statement of technical problem, and results of computer simulation.

Physical Activities and Environmental Conditions:

Work is mostly sedentary.

Talking and hearing involved in discussions with originators of problems.

Near visual acuity required to work accurately with a variety of equations, formulas, charts, and tables.

Work is performed inside.

CARD-TAPE-CONVERTER OPERATOR

**1-25.60
(213.382)**

Occupational Definition

Operates machines that automatically transcribe data from punchcards to reels of tape, or from tape to punched cards, for use in automatic data-processing equipment: Wires plug board to make circuit connections according to prepared diagrams and to print data in desired format. Mounts reels of tape on spindles, places stacks of punchcards in hopper, and starts reading and recording machines. Observes operation of machines to detect malfunctioning. Marks identification on reels of tape or drawers of punched cards at end of run, and keeps control sheet. May transcribe coded program instructions for electronic-data-processing operation onto tape, using electric typewriter equipped with special keyboard [DATA TYPIST]. May operate high-speed printing machine [HIGH-SPEED-PRINTER OPERATOR]. May be designated according to machines operated as CARD-TO-TAPE-CONVERTER OPERATOR; TAPE-TO-CARD-CONVERTER OPERATOR.

Education, Training, and Experience

High school or equivalent education preferred. Experience in handling punched cards for and in operating electromechanical machines, such as sorters and collators, is desirable.

Special Characteristics

Aptitudes:

Clerical perception required in verifying sequence of punched cards for specified types of data, and in recording information on control sheet.

Motor coordination to wire plugboard and set up machine.

Form perception required to follow details of wiring diagrams and to operate machines.

Interests:

A preference for activities of a routine nature.

Temperaments:

Must adapt to work activities that are repetitive and short cycle in nature and are performed under specific instructions when operating machines and wiring plugboard.

Must adhere to established standards of accuracy when wiring plugboards.

Physical Activities and Environmental Conditions:

Light work. Stands and walks most of work period.

Reaching, handling, and fingering involved to operate machines, mount reels of tape on machines, position stacks of punched cards, thread tape into machine, and to wire plugboards.

Near visual acuity to wire plugboards from diagrams, and examine and read cards.

Work is performed inside.

CODING CLERK

1-36.05
(219.388)

Occupational Definition

Converts routine items of information obtained from records and reports into codes for processing by data-typing or key-punch units, using predetermined coding systems; Manually records alphabetic, alphanumeric, or numeric codes in prescribed sequence on worksheet or margin of source document for transfer to punchcards or machine input tape. May be designated according to trade name of computer system as CODING CLERK, UNIVAC; IBM CODER.

Education, Training, and Experience

High school graduation usually is required. Training of a day or two in a classroom situation or under the direction of an experienced worker usually is provided by the employer. Achievement of adequate speed, and particularly the development of a high degree of accuracy, takes from one to three months. Achievement of speed involves memorization of many of the codes. Familiarization with standard business terminology and abbreviations, and with special conventions used by the employer can reduce the time necessary to achieve adequate performance.

Special Characteristics

Aptitudes:

Verbal ability to understand written and oral instructions, business terms, abbreviations, and mnemonic contractions, and to explain difficulties to supervisor.

Clerical perception to scan and extract pertinent detail from source documents, and to avoid and detect perceptual errors.

Interests:

A preference for activities of a routine, concrete, organized nature to code according to a predetermined, standardized system.

Temperaments:

Work activities are repetitive and short cycle in nature. Converts each item into the equivalent code in the allowable time cycle of a few seconds.

Must follow specific instructions to convert items to their coded equivalents which are indexed in tables or handbooks.

Physical Activities and Environmental Conditions:

Work is sedentary. Reaches for, lifts, and handles handbooks, papers, and forms seldom exceeding five pounds.

Near visual acuity to read and convert items to codes.

Work is performed inside.

COMPUTER-PERIPHERAL-EQUIPMENT OPERATOR

**1-25.17
(213.382)**

assistant console operator; tape handler

Occupational Definition

Operates on-line or off-line peripheral machines, according to instructions, to transfer data from one form to another, print output, and read data into and out of digital computer: Mounts and positions materials, such as reels of magnetic or paper tape onto spindles, decks of cards in hoppers, bank checks in magnetic ink reader-sorter, notices in optical scanner, or output forms and carriage tape in printing devices. Sets guides, keys, and switches according to oral instructions or run book to prepare equipment for operation. Selects specified wired control panels or wires panels according to diagrams and inserts them into machines. Presses switches to start off-line machines, such as card-tape converters, or to interconnect on-line equipment, such as tape or card computer input and output devices, and high-speed printer or other output recorder. Observes materials for creases, tears, or printing defects and watches machines and error lights to detect machine malfunction. Removes faulty materials and notifies supervisor of machine stoppage or error. Unloads and labels card or tape input and output and places them in storage or routes them to library. Separates and sorts printed output forms, using decollator, to prepare them for distribution. May operate punchcard tabulating machines, such as sorters and collators.

Education, Training, and Experience

High school graduate. Post-high school training in operation of electronic or electromechanical data-processing equipment is desirable. Employers frequently regard worker as understudy to computer operators and apply same education and aptitude standards to them.

Special Characteristics

Aptitudes:

Verbal ability to read written instructions and handbooks and to communicate with supervisor about operating functions.

Spatial ability to follow diagrams to wire control panels, position and thread tapes onto spindles or position decks of cards in hoppers.

Clerical perception to identify and record, without error, data such as dates, program numbers, departments, and routings on forms.

Motor coordination and finger and manual dexterity to load and unload machines quickly and minimize down-time, to thread ribbons of tape over guides and through rollers, and to handle cards and tapes deftly without bending, tearing, or otherwise damaging them.

Color discrimination to connect wires according to their colors to specified terminals when wiring control panels, or to recognize display lights and their meanings by color.

COMPUTER-PERIPHERAL-EQUIPMENT OPERATOR AT HIGH-SPEED PRINTER



Courtesy of Burroughs Corporation

Interests:

An interest in activities concerned with machines, processes, and techniques to operate various machines. Preference for activities of a routine and organized nature to follow well-defined instructions for any of several different machines.

Temperaments:

Worker must be adept at performing a variety of tasks requiring frequent change to operate a number of machines in varying combinations and sequences.

When operating peripheral equipment, must adhere to established standards for accuracy, such as observing printer output forms for defects in alinement, spacing, margin, and overprinting. Immediate response to indication of error in operation of peripheral equipment is vital.

Physical Activities and Environmental Conditions:

Work is light, involving frequent standing and walking when operating machines and lifting and carrying tapes, cards, and forms not exceeding 20 pounds.

Reaches, handles, and fingers to mount tapes onto spindles, position decks of cards in hoppers, and thread tape through guides and rollers of peripheral units or wire control panels.

Near visual acuity to read labels on reels, to wire plugboards from diagrams, to scan printout for error, and to read operating instructions and handbooks.

Color vision to distinguish between various colors of wires to ensure correct wiring of control panels.

Work is performed inside.

DATA TYPIST

**1-37.32
(213.588)**

Occupational Definition

Converts alphabetic, numeric, and symbolic data into coded form on punchcards or tapes, using special-purpose electric typewriter: Loads decks of punchcards or reels of magnetic or paper tape into machine. Moves switches to set up machine and auxiliary equipment to produce desired cards or tapes. Types computer programs and input data, such as specified items from business forms, which the machine converts to holes or magnetic impulses on cards or tapes. Proofreads typed copy to identify errors, and retypes copy or activates correctional devices built into machine. May insert tape or cards into reader attachment for automatic duplication of business correspondence or records. May be designated according to trade name of machine used as UNITYPIST.

Education, Training, and Experience

High school graduate preferred with demonstrated proficiency in typing on standard or electric typewriter. One week of on-the-job training usually is provided by employer or manufacturer of equipment to learn operation of machine, and up to three months' on-the-job training to become familiar with material typed, such as narrative and tabular forms, programing languages, and conventions.

Special Characteristics

Aptitudes:

Verbal ability to recognize meanings of words, use and spell standard abbreviations and coding conventions to avoid making or duplicating errors when typing copy, or perpetuating errors when proofreading, and to learn words, abbreviations, and conventions commonly used to achieve requisite speed and accuracy.

Spatial ability to ensure arrangement of type on specified line and in specified blocks of forms.

Form perception to identify proper punctuation and special characters which are frequently used in combination with letters and numbers to form codes.

Clerical perception to note pertinent detail in typing and proofreading narrative and tabular material such as program and input data.

Motor coordination to operate typewriter and load machine.

Interests:

Preference for routine, concrete, and organized activity to transcribe items such as program instructions, business correspondence, and other data.

Temperaments:

Required to perform repetitive typing duties.

Must be able to follow written and oral instructions specifying copy to type and format, forms, and machine settings to use.

Physical Activities and Environmental Conditions:

Work is sedentary.

Reaches for and fingers keys and switches on machine. Handles card and paper forms when filling machine and removing printed copy.

Near visual acuity to read copy when typing.

Work is performed inside.

DIGITAL-COMPUTER OPERATOR

**1-25.17
(213.382)**

computer operator; console operator

Occupational Definition

Monitors and controls electronic digital computer to process business, scientific, engineering, or other data, according to operating instructions: Sets control switches on computer and peripheral equipment, such as external memory, data communicating, synchronizing, input, and output recording, or display devices, to integrate and operate equipment according to program, routines, subroutines, and data requirements specified in written operating instructions. Selects and loads input and output units with materials, such as tapes or punchcards and printout forms, for operating runs, or oversees operators of peripheral equipment who perform these functions. Moves switches to clear system and start operation of equipment. Observes machines and control panel on computer console for error lights, verification printouts and error messages, and machine stoppage or faulty output. Types alternate commands into computer console, according to predetermined instructions, to correct error or failure and resume operations. Notifies supervisor of errors or equipment stoppage. Clears unit at end of operating run and reviews schedule to determine next assignment. Records operating and down-time. Wires control panels of peripheral equipment. May control computer to provide input or output service for another computer under instructions from operator of that unit.

Education, Training, and Experience

A high school education meets the minimum educational requirements of some employers, but an increasing number of employers are demanding an additional several months to two years of technical school training in data processing. This training usually includes such courses as data-processing mathematics, accounting, business

DIGITAL-COMPUTER OPERATOR AT CONSOLE



Courtesy UNIVAC Division of Sperry Rand Corp.

practices, elementary programing, and operation of computers, peripheral equipment, and tabulating machines.

The employer or computer manufacturer usually provides one to three weeks of formal instruction for the specific computer system the worker will operate. Length of subsequent on-the-job training and experience required to achieve adequate performance ranges from a few months to one year because computer systems and equipment vary in complexity and need for operator intervention. Except in small units, a minimum of three to six months' prior experience in operation of peripheral equipment frequently is required.

Test: U.S. Employment Service, Specific Aptitude Test Battery B-565

Special Characteristics

Aptitudes:

Verbal ability to comprehend technical language of operating instructions and equipment manuals and to explain clearly any operating problems and difficulties in interpreting program intent.

Numerical ability at level of arithmetic to prepare operating records, time computer runs, and adhere to fixed operating schedule. While not always an operator requirement, an understanding of data-processing mathematics (the number systems used, algebra and logic) is almost essential to discuss operating difficulties with programming personnel, and to progress from routine production runs to the testing of new programs.

Spatial perception to wire control panels for peripheral equipment.

Form perception to identify flaws in input and output materials.

Clerical perception to avoid perceptual errors in preparing operating records, and to recognize alphabetic, numeric, and mnemonic symbols.

Motor coordination, to rapidly set up machines and to move keys and switches to quickly correct errors or stoppages.

Interests:

A preference for working with machines and processes to continuously operate and monitor the equipment that comprises the computer system.

Interest in activities of concrete and organized nature to operate machines according to specific and detailed instructions.

Temperaments:

Work situation requires ability to perform a variety of work tasks subject to frequent change in the simultaneous operation of a console and a variety of peripheral equipment, the integration of which varies from program to program, or even during a single operating run, and which demands rapid transfer of attention from one piece of equipment to another.

Accuracy required to operate system effectively and minimize down-time and re-scheduling of runs. Carelessness in following written and oral instructions can cause extensive rebuilding of program or input data, or even lead to irrecoverable loss of data.

Physical Activities and Environmental Conditions:

Work is light. Lifts, carries, and positions tape reels, punchcard decks, output forms, and control panels seldom exceeding 20 pounds.

Stands and walks frequently when loading and monitoring machines.

Reaches for and fingers switches and keys on console and peripheral machines. Wires control panels, loads and removes input and output materials.

Talking and hearing to frequently exchange information concerning program and system requirements with other workers and to receive or give instructions.

Near visual acuity and accommodation to follow detailed operating log, monitor computer and peripheral machines for signs of malfunction, and analyze console messages or high-speed printer output for cause of error or stoppage.

Color vision to distinguish between colored wires when wiring control panels, to identify color-coded cards or forms and to monitor colored display lights if used. Work is performed inside.

ELECTRONICS MECHANIC, COMPUTER

5-83.444

(828.281)

electronics specialist, computer

Occupational Definition ¹

Repairs electronic analog or digital computers and peripheral equipment, following schematics, diagrams, and handbook instructions: Inserts test programs and data in computer and monitors processing from maintenance or operator's control panel, comparing system performance and output to predetermined standards to analyze cause of machine error or stoppage. Operates or observes computer and peripheral equipment during system and trouble localization tests to locate defective circuits and isolate faulty units. Tests suspect circuits, modules, and components, using oscilloscope and other instruments to diagnose defects. Solders faulty connections and adjusts, repairs, or replaces defective electronic, electromechanical, or mechanical components, according to service manuals, schematics, and diagrams. Performs preventive maintenance duties, such as cleaning unit, mass replacing of transistors or tubes, and testing circuitry by simulating extreme operating conditions to locate and replace marginal components. Keeps maintenance records and maintains parts inventory. May originate testing procedures. May be designated according to type of equipment repaired as ELECTRONICS MECHANIC, ANALOG COMPUTER; ELECTRONICS MECHANIC, DIGITAL COMPUTER.

Education, Training, and Experience

High school graduate. Two years of technical school training in electronics or completion of 2 years of a 4-year electrical engineering program is usually a minimum requirement. Courses in digital or analog computer theory and repair as part of electronics training is desirable. Military training and experience in repair of complex electronic systems such as radar, or more particularly, in special-purpose digital or analog computer systems for such uses as fire control or flight simulation is especially desirable. Manufacturers of computers and peripheral equipment often provide classroom and on-the-job training of up to one year in machine service and repair. This training usually includes operating, and at least rudimentary programing of the computer.

Test: U.S. Employment Service, Specific Aptitude Test Battery B-359

Special Characteristics

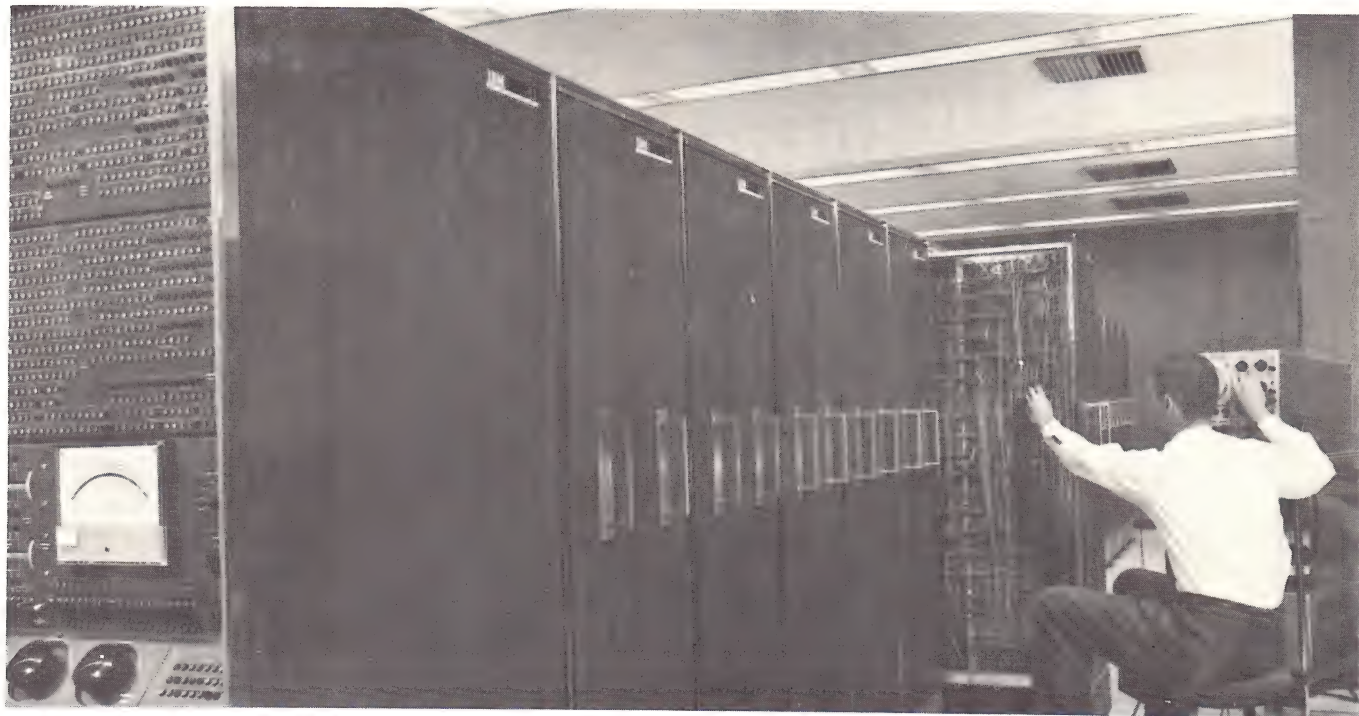
Aptitudes:

Verbal ability to confer with operating personnel about processing errors and machine stoppage or malfunction, to interpret error message printouts, technical handbooks, and test checklists, and to compare output to input data.

Numerical ability at level of arithmetic, binary mathematics, and Boolean algebra to comprehend functions of computer and peripheral equipment circuitry and components, to understand various number systems in which different computers operate, interpret test panel lights, and to calibrate and operate test instruments.

¹ This definition covers only those aspects of the job of ELECTRONICS MECHANIC, published in the DICTIONARY OF OCCUPATIONAL TITLES, that are concerned with the maintenance of electronic computers.

ELECTRONICS MECHANIC, COMPUTER, TESTING CIRCUIT



Courtesy of International Business Machines Corporation

Spatial ability to interpret waveform displays, and to visualize circuitry from schematics and diagrams.

Form perception to check circuitry for such defects as loose or corroded connections, faulty soldering, and presence of dust or other foreign matter.

Clerical perception to perceive pertinent detail in written material, as when comparing printout of test runs with known input data or predetermined answers.

Manual dexterity to use handtools.

Finger dexterity to move small objects in confined workspaces.

Color discrimination to recognize and work with color-coded wiring and components.

Interests:

Interest in activities of a scientific and technical nature to learn electronic theory and practice and keep informed of developments in field by reading technical books, periodicals, and manufacturers' literature concerning changes in equipment and in techniques for testing and troubleshooting.

A preference for activities resulting in tangible, productive satisfaction to repair electronic and electromechanical devices.

Temperaments:

Worker required to perform a variety of tasks, such as instituting a series of tests to diagnose equipment failure and carrying out a sequence of preventive maintenance tasks. Works with a variety of precision equipment, such as square-wave generator, oscilloscope, and voltmeters.

Must be able to make decisions concerning performance of equipment based on factual information such as test data, reference manuals, and predetermined test routines to isolate and identify faulty or marginal components.

Requires ability to work to precise and established standards of accuracy indicated by written specifications and performance requirements of equipment.

Physical Activities and Environmental Conditions:

Work is light, involving lifting and carrying equipment weighing 5 to 10 pounds and occasionally up to 30 pounds, and requires infrequent stooping and crouching.

Reaching, handling, fingering, and feeling to work with handtools and delicate, miniaturized components and modules.

Near visual acuity and accommodation to read handbooks, diagrams, and schematics, to operate precision test instruments, and to repair complex equipment. Color vision to distinguish among colored wires and interpret color codes.

Work is performed inside.

ENGINEERING ANALYST I

0-35.77

(020.088)

applied mathematician; computational engineer; computing analyst; systems analyst, engineering-scientific

Occupational Definition

Formulates mathematical model of scientific, engineering, and other technical problems for solution by digital computer: Analyzes assigned problem such as optimal design configuration of ballistic missile or computer system for industrial process control. Consults with engineering or scientific personnel to refine definition of project and prepare mathematical simulation of physical system under study. Searches library for applicable mathematical formulations and data pertinent to problem. Prepares mathematical model of problem area, such as set of partial differential equations to relate constants and variables, restrictions, alternatives, objectives, and

their numerical parameters, and inserts relevant data. Reduces problem to computer-processable form by applying knowledge of numerical analysis and expresses it in FORTRAN or other procedure-oriented language, or refers formulations to programming personnel. Confers with originator of problem, using knowledge of subject sciences and their language, to discuss adequacy and applicability of computer output or need for reformulation of model. Prepares reports. May use small-scale analog or keyboard-input digital computer to assist in or test parts of model formulation. May supervise other ENGINEERING ANALYSTS I.

Education, Training, and Experience

College degree with emphasis on mathematics and the physical sciences is the minimum educational requirement. Degree, graduate training, and practical experience in one of the fields of engineering, physics, or other area of application is especially desirable. It is necessary to continue education on a part-time basis to be informed of rapid changes and new techniques. Some knowledge of technical programming techniques is essential. A strong background in advanced numerical analysis often is a requirement, but this depends to some extent on the allocation of work tasks between engineering analysts and programmers in an individual installation.

Special Characteristics

Aptitudes:

Verbal ability to interpret technical data and discuss problems with project originators, explain difficulties encountered, and prepare records and reports, using both technical and lay terminology.

Numerical ability to analyze problem, apply pertinent mathematical disciplines, and prepare formulation of physical problem under study in a computer-programable format.

Spatial ability to visualize form and shape of objects as portrayed on blueprints, drawings, diagrams, and other graphic presentations, to formulate problem and interpret results.

Form perception to detect difference or similarity in nonalphanumeric symbologies and in computer printout, such as performance curves.

Clerical perception to detect or avoid making perceptual errors in working with pages of mathematical equations, computer plots, and printouts of design specifications.

Interests:

A preference for activities that are technical in nature to apply mathematical theory and knowledge of subject matter to formulate mathematical representations of proposed products or processes.

Interest in devising mathematical equations.

Temperaments:

Ability to engage in a variety of activities such as problem analysis, engineering consultation, library research, formulation refinement, review of computer output, and report preparation during the course of a single assignment.

Required to make decisions on a judgmental basis when assessing previous formulations for relevance or devising new techniques and procedures.

Required to make decisions on basis of verifiable data, such as engineering tables, and statements of technical problems.

Physical Activities and Environmental Conditions:

Work is sedentary, and involves lifting and carrying books, technical manuals, and computer printout seldom exceeding 10 pounds.

Talking and hearing involved in frequent discussions with originators of projects and with programers to coordinate project efforts and resolve problems.

Near visual acuity required to work accurately with a variety of equations, formulas, charts, and tables.

HIGH-SPEED-PRINTER OPERATOR

**1-25.98
(213.382)**

off-line-printer operator

Occupational Definition

Operates high-speed printing machine to convert scientific, engineering, or business information previously recorded on reels of tape into printed records: Wires plug-board, making circuit connections according to prepared diagram, to obtain specified data in desired format. Mounts tape reels on spindles and positions paper stock, on which data are to be recorded, in printer. Starts machine and observes printing for legibility and format and panel lights for indications of computational errors. Verifies plugboard wiring to correct printing errors. Removes printed sheets from machine and stores reels of tape. May transfer data from punchcards to reels of magnetic tape or from tape to cards [CARD-TAPE-CONVERTER OPERATOR]. May transcribe coded program instruction for electronic data-processing operation onto magnetic tape, using electric typewriter equipped with special keyboard [DATA TYPIST].

Education, Training, and Experience

High school graduate. Experience in operation of variety of machines, such as key punch, verifier, sorter, and wired tabulating device, is helpful.

Special Characteristics

Aptitudes:

Verbal ability to understand written instructions and handbooks and to communicate with supervisor about operating functions.

Form perception required to follow details of wiring diagrams.

Clerical perception to detect errors in printing and format.

Motor coordination to wire plugboards, operate machine, and use typewriter.

Color discrimination to connect wires according to their colors to specified terminals when wiring plugboards and to recognize display lights.

Interests:

A preference for working with machines, processes, and techniques, and for activities that are routine in nature.

Temperaments:

Must be able to perform tasks that are repetitive and short cycle in nature, such as changing reels, and monitoring printer.

Must be able to adhere to established standards of accuracy when wiring plugboards.

Physical Activities and Environmental Conditions:

Work is light. Stands most of workshift. Lifts and carries drawers of punched cards and reels of tape seldom exceeding 20 pounds.

Near visual acuity to read labels on reels, wire plugboards from diagrams, scan printer for errors, and read handbooks.

Color vision to distinguish between various colors of wires.

Work is performed indoors.

KEY-PUNCH OPERATOR

1-25.62

(213.582)

**card-punch operator; printing-card-punch operator;
printing-punch operator**

Occupational Definition

Operates alphabetic and numeric key-punch machine, similar in operation to electric typewriter, to transcribe data from source material onto punchcards and to reproduce prepunched data: Attaches skip bar to machine and previously punched program card around machine drum to control duplication and spacing of constant data. Loads machine with decks of punchcards. Moves switches and depresses keys to select automatic or manual duplication and spacing, selects alphabetic or numeric punching, and transfers cards through machine stations. Depresses keys to transcribe new data in prescribed sequence from source material into perforations on card. Inserts previously punched card into card gage to verify registration of punches. Observes machine to detect faulty feeding, positioning, ejecting, duplicating, skipping, punching, or other mechanical malfunctions and notifies supervisor. Removes jammed cards, using prying knife. May tend machines that automatically sort, merge, or match punchcards into specified groups. May key-punch numerical data only and be designated KEY-PUNCH OPERATOR, NUMERIC.

Education, Training, and Experience

High school graduate preferred with demonstrated proficiency in typing on standard or electric typewriter. High school or business school training in key-punch operation is desirable. Frequently, one week of training is provided by employer or manufacturer of equipment.

Test: U.S. Employment Service, Specific Aptitude Test Battery B-499

Special Characteristics

Aptitudes:

Verbal ability to understand oral and written instructions, such as manufacturers' operating manuals, and to learn operation of machine.

Clerical perception to perceive pertinent detail in tabular material consisting of combinations of letters and numbers, and avoid perceptual error in transferring this data to punchcards.

Motor coordination to read work sheets and simultaneously operate keyboard of approximately 40 keys to punch data on cards.

Finger dexterity to move switches on machine.

Interests:

Preference for organized and routine activities to transfer data onto punchcards.

Temperaments:

Must be able to perform repetitive duties of operating key-punch machine.

Ability to follow specific instructions and set procedures to transfer data onto punchcards.

Required to work to precise and established standards of accuracy to key punch data at high rate of speed.

Physical Activities and Environmental Conditions:

Work is sedentary with infrequent lifting of decks of cards when loading machine. Reaches for and handles code sheets, business records, and decks of cards; fingers switches and keys to operate machine.

Near visual acuity to read copy when key punching.

Work is performed inside.

MANAGER, ELECTRONIC DATA PROCESSING

**0-97.16
(169.168)**

director, data processing

Occupational Definition

Directs and coordinates planning and production activities of electronic data-processing division: Consults with management to define boundaries and priorities of tentative projects, discuss equipment acquisitions, determine specific information requirements of management, scientists, or engineers, and allocate operating time of computer systems. Confers with department heads involved with proposed projects to ensure cooperation and further define nature of project. Consults with SYSTEMS ENGINEER, ELECTRONIC DATA PROCESSING to define equipment needs. Reviews project feasibility studies. Establishes work standards. Assigns, schedules, and reviews work. Interprets policies, purposes, and goals of organization to subordinates. Prepares progress reports to inform management of project development and deviation from predicted goals. Contracts with management specialists or technical personnel to solve problems. Revises computer operating schedule to introduce new program testing and operating runs. Reviews reports of computer and peripheral equipment production, malfunction, and maintenance to ascertain costs and plan operating changes within his department. Analyzes data requirements and flow to recommend reorganization or departmental realignment within company. Participates in decisions concerning personnel staffing and promotions within electronic data-processing departments. Directs training of subordinates. Prepares proposals and solicits purchases of systems analysis, programing, and computer services from outside firms.

Education, Training, and Experience

Two years of formal post-high school training in data processing with courses in business administration and accounting or engineering, or equivalent practical experience is necessary for small computer installations. College graduation with major in one or more of the above fields is preferred for large installations. Experience in systems analysis, programing, and computer operations is desirable. In installations offering more sophisticated services, such as operations research and engineering simulation, a college mathematics major coupled with experience listed above is desirable.

Special Characteristics

Aptitudes:

Verbal ability to translate technical terminology into terms understandable to management and department heads.

Numerical ability to apply knowledge of linear or differential equations in evaluating work of department, preparing reports and proposals for management, and selling services to outside users.

Spatial ability to read engineering drawings, charts, and diagrams; to understand presentations, proposed solutions, and progress reports of business or engineering problems.

Form perception to see pertinent detail in drawing charts, diagrams, and other presentations.

Clerical perception to detect and avoid errors in reading and preparing reports.

Interests:

An interest in scientific and technical subjects to cope with wide range of technical and scientific problems processed through computer.

A preference for business contacts with people in directing activities of computer department and to sell ideas or services.

Temperaments:

Must be able to direct, control, and plan the operations of the division, bringing together knowledge of operations and information needs of departments, such as accounting, purchasing, engineering, sales, and inventory control.

Required to deal with people such as management, department heads, and manufacturers' representatives to exchange information and ideas, discuss equipment and their uses, elicit information from departments, and to answer inquiries from department heads.

Ability to influence management and department heads to enlist their support for acceptance, expansion, and sophistication of computer systems; and ability to sell excess computer time and services to outside clients.

Required to make judgmental decisions concerning equipment needs, scope of assignments, allocation of computer time, and organization of departments.

Required to make decisions based on factual data to evaluate progress or success of computerized projects.

Physical Activities and Environmental Conditions:

Work is sedentary.

Occasionally walks to various departments and offices; stands during conferences and discussions with management, department heads, and supervisor of computer operations.

Talking and hearing required in conferences and during exchanges of information.

Near visual acuity and accommodation required for reading reports and charts.

Work is performed inside.

OPERATIONS RESEARCH ANALYST

**0-35.78
(020.088)**

management-operations analyst; operations analyst

Occupational Definition

Formulates mathematical model of management problems by application of advanced mathematics and research methods to provide quantitative basis for planning, forecasting, and making decisions: Analyzes problems in terms of management information requirements. Studies problem, such as selecting from competitive proposals a plan that affords maximum probability of profit or effectiveness in relation to cost or risk. Prepares mathematical model of problem area in form of one or several equations that relate constants and variables, restrictions, alternatives, conflicting objectives, and their numerical parameters. Gathers, relates, and identifies data with variables in model by applying personal judgment and mathematical tests.

Specifies manipulative and computational methods to be applied to formulations and refers to data-processing division for solving equations, programing, and processing. Reviews operations and testing of model to ensure adequacy or determine need for reformulation. Prepares written, nontechnical reports to management, indicating problem solution or range of possible alternatives in rank of desirability and probability of success when there is no single solution. Writes followup reports, evaluating effectiveness of research implementation. May specialize in research and preparation of contract proposals specifying the competence of an organization to perform research, development, or production work. May develop and apply time and cost networks, such as Program Evaluation and Review Technique (PERT), to plan and control large-scale business projects. May work in areas associated with engineering, as when analyzing and evaluating alternative physical systems, such as production processes, in terms of effectiveness and cost. May work alone or as member of a team.

Education, Training, and Experience

College degree with emphasis on advanced mathematics and statistics is usually the minimum educational requirement. A combination of advanced degrees in mathematics and business administration is especially desirable. A doctorate in mathematics is frequently required. Specific training in operations research at the graduate level is rapidly becoming a standardized requirement, as more schools offer courses in this interdisciplinary occupational area. Many workers have acquired the necessary background in mathematics through education and experience in engineering and the physical sciences, and knowledge of specialized techniques through self-study and participation in activities of professional organizations.

Special Characteristics

Aptitudes:

Verbal ability to understand technical languages of various professional disciplines such as engineering and accounting, to give oral reports and to prepare written reports on results of research in lay terminology to management.

Numerical ability to understand and work with such mathematical specializations as game, queuing, and probability theory, and statistical inference to prepare formulations, specify manipulative methods and evaluate effectiveness.

Spatial ability to prepare and interpret charts, diagrams, graphs, and maps.

Clerical perception to recognize pertinent detail in compilation and analysis of statistical data, and to avoid perceptual errors in working with higher forms of mathematics.

Interests:

A preference for activities that are technical in nature to apply analytical, experimental, and quantitative techniques in the solution of management problems such as long-range forecasting, planning, and control.

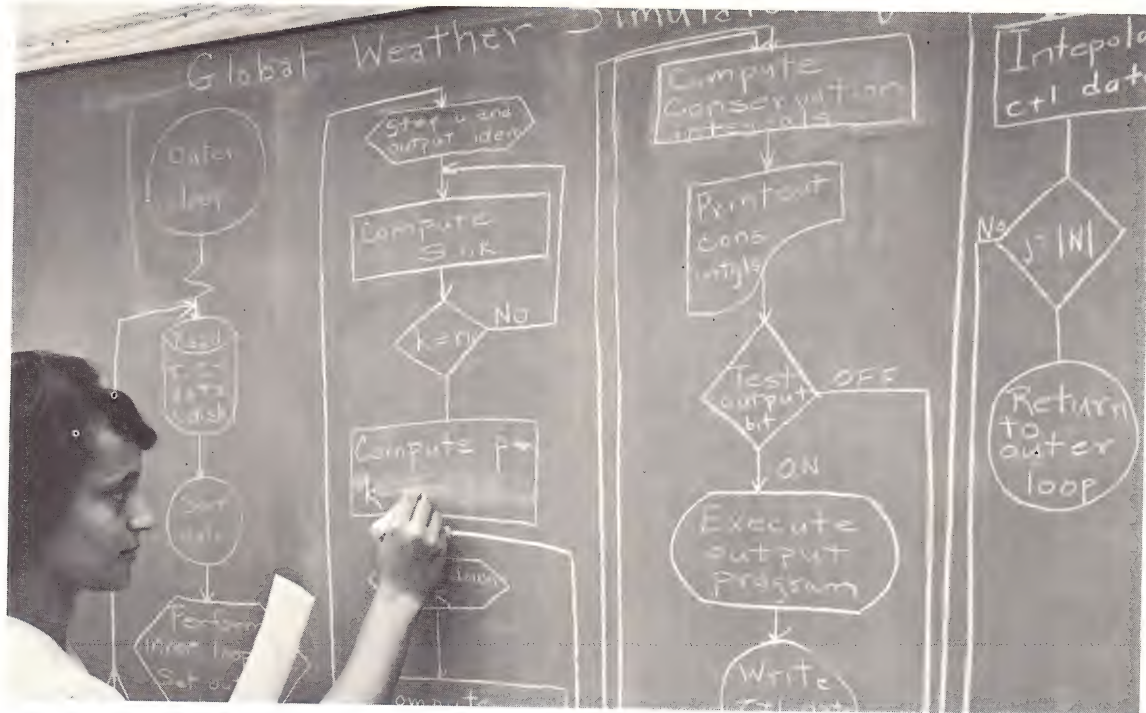
Interests in devising mathematical equations, analyzing the methods used for their manipulation, and evaluating their practical effectiveness.

Temperaments:

Requires ability to perform a variety of tasks related to the solution of various problems on all departmental levels. This involves conversing in several professional disciplines with personnel at all operating levels to gather and relate data and opinions relevant to problem under study.

Must possess ability to make judgmental decisions such as probability of continuity or change in conditions, and assign arbitrary weights and values to problem factors when conventional statistical methods are not applicable.

PROGRAMMER



Courtesy of International Business Machines Corporation

Must possess ability to make decisions based on verifiable data, such as tabular records of previous organizational experience.

Physical Activities and Environmental Conditions:

Work is sedentary, and occasionally involves lifting and carrying books, ledgers, and statistical tabulations seldom exceeding 10 pounds.

Talking and hearing to discuss organization goals and priorities with management and acquire data pertinent to the problem from other organizational personnel.

Near visual acuity to read and work with a variety of data from many sources, and to refer to texts and technical papers.

Work is performed inside.

PROGRAMER, BUSINESS

0-69.981

(020.188)

digital-computer programmer

Occupational Definition

Converts symbolic statement of business problems to detailed logical flow charts for coding into computer language: Analyzes all or part of workflow chart or diagram representing business problem by applying knowledge of computer capabilities, subject matter, algebra, and symbolic logic to develop sequence of program steps. Confers with supervisor and representatives of departments concerned with program, to resolve questions of program intent, output requirements, input data acquisition, extent of automatic programing and coding use and modification, and inclusion of internal checks and controls. Writes detailed, logical flow chart in symbolic form to represent work order of data to be processed by the computer system, and describe input, output, arithmetic, and logical operations involved. Converts detailed, logical flow chart to language processable by computer [PROGRAMER, DETAIL]. Devises sample input data to provide test of program adequacy. Prepares block diagrams to specify equipment configuration. Observes or operates computer to test coded program, using actual or sample input data. Corrects program errors by such methods as altering program steps and sequence. Prepares written instructions (run book) to guide operating personnel during production runs. Analyzes, reviews, and rewrites programs to increase operating efficiency or adapt to new requirements. Compiles documentation of program development and subsequent revisions. May specialize in writing programs for one make and type of computer.

Education, Training, and Experience

Minimum requirement is high school graduation with six months to two years of technical training in computer operations and in general principles of programing and coding, or equivalent job experience in these areas. Current trend is to hire college graduates for promotional potential with training in accounting, business administration, and mathematics, and provide them with a year of on-the-job training to qualify them for programing. In installations concerned with the application of the computer to more complex areas such as market research and statistical forecasting, a college degree in mathematics is preferred.

Special Characteristics

Aptitudes:

Must possess verbal ability to understand and analyze oral or written statements concerning a variety of business problems and to discuss them with others.

Must possess numerical ability to interpret workflow charts, program problems, and understand machine logic. Level of mathematics varies from arithmetic and algebra for simple business data-processing problems to differential equations and mathematical statistics for involved problems such as forecasting or optimization.

Must possess spatial ability to interpret diagrammatic representations of workflow, and to visualize flow of data through computer system to prepare computer block diagrams and logical flow charts.

Must possess form perception to see pertinent detail in symbols when reading, interpreting, or preparing charts, diagrams, and code sheets.

Clerical perception to detect errors in letters, words, and numbers recorded on charts, diagrams, and code sheets.

Interests:

An interest in activities technical in nature to effectively analyze problems, and to design logical flow charts and block diagrams.

An interest in activities that are carried out in relation to processes, techniques, and machines to plan sequence steps, to prepare instructions, and to test programs.

Temperaments:

Required to make judgmental decisions to plan logical sequence of steps and prepare logical flow chart for a project, keeping in mind capacities and limitations of computer and integrated machine units.

Must be able to conform to accepted standards and techniques in developing and testing programs, and writing instructions for computer operators to follow.

Physical Activities and Environmental Conditions:

Work is sedentary, requiring occasional lifting and carrying of such items as source materials, run books, and documentations seldom exceeding 10 pounds.

Talking and hearing to communicate with systems, program coding, and operating personnel.

Near visual acuity and accommodation required to review statistical data and interpret charts and diagrams.

Work is performed inside.

PROGRAMER, CHIEF, BUSINESS

0-69.981

(020.168)

coordinator, computer programing; lead programmer

Occupational Definition

Plans, schedules, and directs preparation of programs to process business data by electronic data-processing equipment: Consults with managerial and systems analysis personnel to clarify program intent, indicate problems, suggest changes, and determine extent of automatic programing and coding techniques to use. Assigns, coordinates, and reviews work of programing personnel. Develops own programs and routines from workflow charts or diagrams. Consolidates segments of program into complete sequence of terms and symbols. Breaks down program and input data for successive computer passes, depending on such factors as computer storage capacity and speed, extent of peripheral equipment, and intended use of output data. Analyzes test runs on computer to correct or direct correction of coded program and input data. Revises or directs revision of existing programs to increase operating efficiency or adapt to new requirements. Compiles documentation of program development and subsequent revisions. Trains subordinates in programing and program coding. Prescribes standards of terminology and symbology to simplify interpretation of programs. Col-

laborates with computer manufacturers and other users to develop new programming methods. Prepares records and reports.

Education, Training, and Experience

Graduation from a technical school or college with training in business administration, computer programming, data-processing mathematics, logic, and statistics is the usual educational requirement. Usually, a minimum of two years' experience in programming for same or similar computer system, on broadscope and complex projects is required. Experience should indicate knowledge of organization structure and workflow, and also reflect proven ability to supervise others and coordinate work activities of the group supervised with that of other organizational units.

Special Characteristics

Aptitudes:

Verbal ability to present oral and written reports and recommendations and to read technical literature about changes in techniques and equipment.

Numerical ability to program at level of linear and Boolean algebra (logic) to minimize expensive programming and debugging time. Mathematics at level of differential equations and probability theory frequently required when an organization is developing or using sophisticated, integrated management information and forecasting systems.

Spatial ability to interpret systems statement, develop general and detailed computer flow charts, and prepare block diagrams that indicate hardware configuration.

Form perception to see pertinent detail in charts, diagrams, and code sheets composed of symbols.

Clerical perception to refer to manuals and written instructions and to review own work. This requires accurate identification of numbers, letters, words, and acronyms as well as ability to grasp general content.

Interests:

A preference for activities that are technical in nature to apply mathematics and logic in converting proposed business systems to computer-processable form.

Temperaments:

Ability to perform a variety of duties, covering problems from different but related areas of business activity such as production and inventory control, and sales analysis.

Must be able to direct, control, and plan development of business data-processing programs that will meet current and future needs. This involves direction of activities, such as program testing and revising, and coordination of all phases of business programming activities to meet schedules.

Required to deal with subordinates for purposes of control and coordination, and with systems analysis and management personnel to resolve questions of intent and programming difficulties.

Required to make judgmental decisions based on experience to assign personnel and select and apply techniques that will produce least cost, fastest, or most flexible programs.

Required to make decisions based on factual data to evaluate adequacy of completed program by comparing program, test and operating runs with prescribed standards of terminology, accuracy, and time.

Physical Activities and Environmental Conditions:

Work is sedentary. Lifts and carries source and output data, books, charts, and diagrams seldom exceeding 10 pounds.

Stands, walks, talks, and hears in instructional and conference situations.

Near visual acuity to prepare, integrate, or modify complex programs, using a variety of charts, diagrams, and handbooks.

Work is performed inside.

PROGRAMER, DETAIL

0-69.981

(219.388)

junior programer; program coder

Occupational Definition

Selects symbols from coding system peculiar to make or model of digital computer and applies them to successive steps of completed program for conversion to machine-processable instructions: Reads and interprets sequence of alphabetic, numeric, or special characters from handbook or memory for each program step to translate it into machine language or pseudo (symbolic) code that can be converted by computer processor into machine instructions. Records symbols on worksheet for transfer to punchcards or machine input tape. Marks code sheet to indicate relationship of code to program steps to simplify debugging of program. Confers with programming personnel to clarify intent of program steps. Usually works as understudy to PROGRAMER, BUSINESS performing such additional tasks as converting flow charts and diagrams of simple problems from rough to finished form, or making minor changes in established programs to adapt them to new requirements.

Education, Training, and Experience

Must be high school graduate. Some training in programming, coding, and computer operations at technical school level is desirable. Experience in computer operations is preferred, but six months of job experience, most often in a clerical capacity, to become familiar with company operations, workflow, standards, and terminology is the minimum requirement. One to four weeks classroom training in coding for specific computer is usually provided by employer or computer manufacturer. Some employers favor college graduates in order to enhance the worker's promotion potential.

Special Characteristics

Aptitudes:

Verbal ability to recognize programming and coding language consisting of abbreviated words, grouping of numbers, symbols, or mnemonics.

Numerical ability to convert decimal numbers to binary or other number systems.

Form perception to recognize and remember graphic symbols (arrangement of lines and curves).

Clerical perception to select from handbooks codes acceptable to computer, which involves accurate identification and recording of numbers, letters, and words.

Interests:

A preference for activities of a routine, concrete and organized manner to code program, using standardized codes.

Temperaments:

Ability to perform repetitive tasks according to set procedures to refer to source books for symbolologies and select appropriate codes for each detailed step in program. Steps may number into the thousands.

Required to work to precise and established standards of accuracy in recognition of steps of detailed program and in selecting and recording codes. Any mistakes

can introduce error into programs and either prevent processing or distort output of program when processed.

Physical Activities and Environmental Conditions:

Work is sedentary. Work sheets and code books seldom exceed five pounds.

Continuously handles pencils, work sheets, and code books while interpreting program steps, finding representative coding, and posting codes to work sheets.

Near visual acuity to select correct alphabetical, numerical, or special symbols to convert detailed program to machine-processable form.

Work is performed inside.

PROGRAMER, ENGINEERING AND SCIENTIFIC

0-69.981

(020.188)

programer, technical

Occupational Definition

Converts scientific, engineering, and other technical problem formulations to format processable by computer: Resolves symbolic formulations, prepares logical flow charts and block diagrams, and encodes resolvent equations for processing by applying knowledge of advanced mathematics, such as differential equations and numerical analysis, and understanding of computer capabilities and limitations. Confers with engineering and other technical personnel to resolve problems of intent, inaccuracy, or feasibility of computer processing. Observes or operates computer during testing or processing runs to analyze and correct programing and coding errors. Reviews results of computer runs with interested technical personnel to determine necessity for modifications and rerun. Develops new subroutines for a specific area of application, or expands on applicability of current general programs, such as FORTRAN, to simplify statement, programing, or coding of future problems. May supervise other programing personnel. May specialize in single area of application, such as numerical control, to develop processors that permit programing for contour-controlled machine tools in source-oriented language.

Education, Training, and Experience

College degree with major in mathematics or engineering is usually the minimum educational requirement. A master's degree or doctorate in mathematics or engineering is a common requirement where analysis or programing is extremely complex or where work duties involve basic research in mathematics or programing. From two to four years of on-the-job training, with gradually decreasing amounts of supervision and with increasingly complex work assignments, are regarded as necessary for the worker to become familiar with at least one class of computer, programing language, and applications area. Short (one to four weeks) training sessions are given by employers and computer manufacturers to provide basic training and (later) specialized training. Current trends toward simplification of programing languages and greater applicability of generalized programs, and requirement of basic computer orientation and programing courses for college degree in physical sciences or engineering will reduce on-the-job training time.

Test: U.S. Employment Service, Specific Aptitude Test Battery B-545

Special Characteristics

Aptitudes:

Verbal ability to discuss problems and equipment requirements with other technical personnel, to prepare computer flow charts, written records, reports, and recommendations and to read technical publications.

Numerical ability to interpret mathematical formulation, to select from alternative computational methods, to frame program within limitations of the computer to be used, prepare logical flow charts and diagrams, to convert program steps to coded computer instructions, and to review work. Level of mathematics may vary from arithmetic and algebra to advanced differential equations in the course of writing a single program, and may also include applications of numerical analysis.

Spatial ability to prepare logical flow charts specifying sequences of operating instructions and flow of data through computer system, to design input and output forms, and to interpret detailed drawings, diagrams, and other graphic data.

Form perception to see pertinent detail in charts, diagrams, and drawings, and distinguish symbols in subject matter areas such as physics and electrical engineering.

Clerical perception to avoid perceptual errors in recording of alphanumeric and special symbolologies.

Motor coordination to operate calculator or computer.

Interests:

A preference for activities technical in nature to use mathematics to reduce formulations to computer-processable form.

Temperaments:

Required to make decisions on a judgmental basis, using past experience and knowledge to select best method of programing and coding a problem and thereby avoiding costly, time-consuming analyses of alternate techniques.

Required to make factual decisions, such as evaluation of program accuracy by computer acceptance, presence of error messages or obvious output distortions.

Must be able to conform to accepted standards and techniques in developing and testing programs, and in writing instructions for digital-computer operator.

Physical Activities and Environmental Conditions:

Work is sedentary, requiring occasional lifting and carrying of source data, books, charts and diagrams seldom exceeding 10 pounds.

Talking and hearing to confer and collaborate with other technical personnel.

Near visual acuity to prepare logical flow charts from lengthy mathematical statements of problem, and to convert program steps to coded computer instructions.

Work is performed inside.

PROJECT DIRECTOR, BUSINESS DATA PROCESSING

0-68.505

(020.168)

**business-systems coordinator; lead analyst; program manager;
project planner; senior systems analyst, business**

Occupational Definition

Plans, directs, and reviews business electronic data-processing project : Coordinates planning, testing, and operating phases to complete project with maximum balance of planning and equipment time, man hours, and new equipment expenditures. Prepares project feasibility and progress reports. Confers with department heads who provide input and use output data to define content and format. Schedules and assigns duties to OPERATIONS RESEARCH ANALYSTS based on evaluation of their knowledge of specific disciplines. Coordinates activities of workers performing successive phases of problem analysis, solution outlining, solution detailing, program coding, testing, and debugging (error elimination). Reviews output data and re-

lated reports, applying knowledge of systems, procedures, methods, and data requirements of management and other output users to ensure adherence to predetermined standards and devise techniques for improved performance on similar future projects. Directs revision of continuous control project to adapt it to new data requirements or improve operations by using new techniques or equipment.

Education, Training, and Experience

A bachelor's or master's degree in business administration, with extensive course content in accounting and mathematics or statistics often is required. Employers frequently waive academic training requirements for currently employed workers with extensive systems analysis, design and followup responsibility in electronic data-processing, and supervisory experience in tabulating-machine departments. Employers frequently require a degree or equivalent experience either in industrial engineering, or the engineering discipline most directly related to their manufacturing processes, when expanding business data processing to an integrated system that includes production forecasting, planning, and control.

Background knowledge and experience usually includes a minimum of one to three years' experience in systems analysis and concurrent familiarization with structure, work flow requirements, and standards of the employing organization.

Current trend is toward greater mathematical sophistication than previously expected of workers at this level. The need for advanced mathematics becomes more urgent as computer applications become involved not only with normal business data-processing, but also with the involved problems of operations research.

Special Characteristics

Aptitudes:

Verbal ability to elicit information and discuss project intentions, problems and progress, and to prepare reports.

Numerical ability to analyze problems and develop systems statements in form capable of being programed. Mathematics varies from arithmetic and algebra for simple, single-purpose systems design to differential equations and mathematical statistics for complex systems involving optimization, simulation, or forecasting.

Spatial ability to develop, interpret, or integrate operational workflow diagrams and charts.

Clerical perception to recognize pertinent detail and avoid perceptual errors when working with verbal material, which often is in highly contracted and conventionalized form.

Interests:

A preference for prestige-type activities, and for business contact with others to participate in conferences with management, advise and inform others regarding the potentialities, limitations, and alternative methods of data processing, supervise analysts and coordinate their activities.

A preference for activities that are technical in nature to read and keep informed of computer development and new or more refined systems and procedures techniques.

Temperaments:

Ability to perform a variety of duties involving frequent change, ranging from direct involvement in problem analysis to coordination of subsequent work processes until each project is operational.

Must be able to direct and plan an entire area of work activity, assigning subordinates on the basis of knowledge of individual specializations and abilities, and control activities through personal contact and reports.

Must be able to deal with people in nonsupervisory situations requiring considerable tact, to secure cooperation from management and all personnel affected by project.

Required to make decisions on a judgmental basis when supervising others and developing approaches to problems on basis of past experience. Evaluates fixed cost, time, manpower allocation, and output specifications to judge efficiency of project development and operation.

Required to make decisions based on factual data, as in planning proposed system around capabilities and limitations of a specific computer system.

Physical Activities and Environmental Conditions:

Work is sedentary, with occasional standing and walking required.

Occasionally lifts and carries books, charts, diagrams, and other records seldom exceeding 10 pounds.

Talking and hearing to discuss problems and progress, and coordinates work activities of others.

Near visual acuity to work with reports, charts, and diagrams and other printed or written records.

Work is performed inside.

SORTING-MACHINE OPERATOR

**1-25.63
(213.885)**

card-sorting-machine operator; sorter-machine operator

Occupational Definition

Tends machine that automatically sorts perforated tabulating cards into specified groups: Ruffles cards to prevent overfeeding, and jamming, and places cards in feed-box. Pushes buttons on sorting control panel to regulate sorting process. Starts machine and sights through holes to verify sorting. Removes sorted cards from bins. Removes jammed cards to clear machine. May reproduce damaged cards on key-punch machine. May operate tabulating machine, verifying machine, or switchboard.

Education, Training, and Experience

High school graduation required. Usually, three months' on-the-job training to learn machine operation and gain proficiency.

Special Characteristics

Aptitudes:

Motor coordination to push buttons on sorting-machine control panel to regulate sorting process.

Manual dexterity to riffle and handle cards.

Interests:

Preference for activities of a routine, organized nature to perform repetitive tasks of tending machine.

Temperaments:

Must be able to perform repetitive tasks of placing and removing cards, pushing control buttons, and starting machine.

Ability to work under specified instructions with little independent action involved.

Physical Activities and Environmental Conditions:

Light work. Stands most of work shift.

Reaches for and handles cards.

Near visual acuity to sight through punched holes.

Work is performed inside.

SUPERVISOR, COMPUTER OPERATIONS

**1-47.03
(213.138)**

chief console operator; senior console operator; supervisor, data processing; supervisor, electronic data processing

Occupational Definition

Supervises and coordinates activities of workers who operate electronic data-processing machines: Assigns personnel and schedules workflow to facilitate production. Directs training or trains personnel in operation of computers and peripheral and off-line auxiliary equipment. Works with programing personnel in testing new and revised programs. Develops operating methods to process data, such as devising wiring diagrams for peripheral equipment control panels, and making minor changes in canned (standardized) programs or routines to modify output content or format. Directs insertion of program instructions and input data into computer, and observes operations. Aids operators in locating and overcoming error conditions. Makes minor program and input data revisions through computer console to maintain operations. Notifies programing and maintenance personnel if unable to locate and correct cause of error or failure. Revises operating schedule to adjust for delays. Prepares or reviews records and reports of production, operating, and down-time. Recommends changes in programs, routines, and quality control standards. Consults with MANAGER, ELECTRONIC DATA PROCESSING about problems, such as including new program testing and operating runs in schedule and arranging for preventive maintenance time. Coordinates flow of work between shifts to assure continuity. May supervise personnel engaged in key-punching, data typing, and tabulating.

Education, Training, and Experience

High school graduation is the minimum requirement. Usually a minimum of one to three years' experience in operating computers, peripheral, and off-line equipment is required. A familiarization with programing and coding techniques usually gained through experience in computer operation or a course in programing are additional prerequisites. However, a 2-year post-high school training course in electronic data-processing may reduce experience requirements. Training in business administration, mathematics, and accounting is regarded as particularly desirable. Some employers require a college degree, particularly in large installations where work duties are largely administrative, and also in order to enhance the worker's promotion potential. Experience in supervising personnel is desirable.

Special Characteristics

Aptitudes:

Verbal ability to train and supervise subordinates, confer with other supervisory and technical personnel, and prepare records and oral or written reports.

Numerical ability to level of arithmetic and algebra to cope with error or stoppage situations in computer operations; to plan operating changes; and to prepare variety of reports, often on a daily basis such as revision of average time requirements for processing data or cost allocations to departmental users.

Spatial and form perception to prepare wiring diagrams, wire control panels for peripheral machines, and operate equipment.

Clerical perception to review records of production, operating and down-time, and recognize pertinent detail in computer printout dumps (rejects).

Interests:

A preference for business contact with others to confer with management, technical personnel, suppliers of input data, and users of computer output, and to supervise and train subordinates.

A preference for activities that are technical in nature to keep informed on operation of new equipment and of new techniques for operation of current machines.

Temperaments:

Ability to perform a variety of tasks subject to frequent change, such as training and assigning personnel, accommodating changes in production schedules to meet priority runs, maintaining records, and developing new operating procedures.

Must be able to direct, control, and plan the activities of computer operators, satellite input-output computer operators, on-line and off-line peripheral equipment operators, and tape librarians.

Required to deal with people such as other departmental supervisors to resolve problems concerned with scheduling, and adequacy and accuracy of input data.

Required to make decisions on a judgmental basis to set up work assignments that make maximum use of workers' knowledge and ability, and most effective and economical use of computers and peripheral equipment.

Required to make decisions on a factual basis when developing schedules for processing programs, relating such factors as date of program receipt, priority assignment, estimated run time, and available computer time. Compares output requirements against available equipment, and existing programs, routines, wiring diagrams, and control panels to determine need for developing or modifying operational methods, or altering operating schedule.

Physical Activities and Environmental Conditions:

Work is light, requiring frequent standing and walking and occasional lifting and handling of reels of tape, decks of punchcards, and control panels weighing up to 20 pounds.

Talking and hearing to give oral instructions, assign work, and train personnel. Confers with management and others, discussing such items as budget requirements and staffing, machine capability, and production problems.

Near visual acuity to frequently analyze records, prepare reports, study program run books, and read technical literature.

Work is performed inside.

SYSTEMS ANALYST, BUSINESS ELECTRONIC DATA PROCESSING

0-69.985

(012.168)

**commercial-systems analyst and designer; data-methods analyst;
systems and procedures analyst, business data processing**

Occupational Definition

Analyzes business problem, such as development of integrated production, inventory control and cost analysis system, to refine its formulation and convert it to programable form for application to electronic data-processing system: Confers with PROJECT DIRECTOR, BUSINESS DATA PROCESSING and department heads of units involved to ascertain specific output requirements, such as types of breakouts, degree of data summarization, and format for management reports. Confers with personnel of operating units to devise plans for obtaining and standardizing input data. Studies

current, or develops new systems and procedures to devise workflow sequence. Analyzes alternative means of deriving input data to select most feasible and economical method. Develops process flow charts or diagrams in outlined and then in detailed form for programing, indicating external verification points, such as audit trial printouts. May work as member of team, applying specialized knowledge to one phase of project development. May coordinate activities of team members. May direct preparation of programs.

Education, Training, and Experience

College graduation with courses in business administration and accounting usually is required for entrants without prior experience in data-processing. Some employers, while requiring a college degree, do not require a specific major or course content. A successful college record is regarded as proof of ability to reason logically which is considered more important for successful performance than knowledge of techniques acquired in any specific area. Many employers waive the formal education requirements for those workers employed in their establishments who have had several years' manual and machine systems experience prior to computer conversion. Business programmers without a college degree can, through experience, acquire a background in business systems and procedures and may thereby advance into systems analysis. Currently, the trend is to require a knowledge of advanced mathematics because of the rapidly increasing sophistication of business systems. Continuing education, through specialized courses, self-study, and participation in activities of professional associations, is the rule rather than the exception in this occupation, as in all higher level occupations related to the computer.

Test: U.S. Employment Service, Specific Aptitude Test Battery B-558

Special Characteristics

Aptitudes:

Verbal ability to discuss problems and progress, prepare reports, and make annotations for graphic representations of work.

Numerical ability to select from alternatives to develop optimum system, procedures and methods. Mathematical investigation of such factors as variation in volume of input data, and frequency of appearance of exceptions to normal workflow in processing is often necessary. Level of mathematics varies from business arithmetic and algebra to differential equations.

Spatial ability to visualize, prepare, and review two-dimensional graphic representations of workflow.

Form perception to identify nonverbal symbols on records such as block diagrams and flow charts.

Clerical perception to avoid perceptual errors and recognize pertinent detail in the recording and identifying of letters and numbers that often occur in abbreviated or acronymic combinations.

Interests:

A preference for activities that are technical and analytical, and those that are abstract and creative in nature to devise new or to modify standardized computer-oriented systems to meet the specific needs of an organization.

Temperaments:

Ability to confer with personnel from other departments, develop flow charts, devise workflow sequence, and prepare reports.

Required to deal with people in conference and interview situations.

Required to make judgmental decisions to select from alternatives when devising optimal system.

Required to make decisions on basis of factual data to design system within machine capability.

Physical Activities and Environmental Conditions:

Work is sedentary, with occasional standing and walking. Occasional handling of source documents, books, charts, and other records that seldom exceed 10 pounds.

Talking and hearing to discuss and confer with management and technical personnel to devise suitable business systems.

Near visual acuity to prepare and review workflow charts and diagrams.

Work is performed inside.

SYSTEMS ENGINEER, ELECTRONIC DATA PROCESSING

0-17.03

(003.187)

computer systems engineer; methods analyst, electronic data processing

Occupational Definition

Analyzes electronic data-processing projects to determine equipment requirements: Confers with **MANAGER, ELECTRONIC DATA PROCESSING** concerning availability and capabilities of equipment in current use, and with **PROJECT DIRECTOR, BUSINESS DATA PROCESSING** to specify computer system requirements for projects. Analyzes capabilities and limitations of computers and peripheral equipment, such as data-recording, communicating, input, output, and synchronizing (buffering) devices, in order to recommend most feasible new equipment or equipment modifications. Plans layout of computers and peripheral equipment to achieve efficient operation and effective use of assigned space. May specify power supply requirements and configuration and recommend purchase and arrangement of air conditioning equipment to control temperature, humidity, and dust. May specialize in one area of equipment application or in one make or type of equipment. Usually is employed as representative of consulting firm or equipment manufacturer.

Education, Training, and Experience

College graduation in electrical or related engineering field is usually required. Additional training in business administration or industrial management is desirable to understand problems of computer users. Formal training program by employing computer manufacturer of up to one year is the usual method of entry into this occupation. Experience in systems analysis, programing, and computer operations could be an alternate requirement.

Special Characteristics

Aptitudes:

Verbal ability to write reports of findings and recommendations, to discuss problems with corporate management and department heads in language understandable to them, and to read manufacturers' manuals and related technical magazines and publications.

Numerical ability at a level of differential equations to understand problems of systems analysis, programing, and computer operations related to selection of most feasible equipment for present and future use.

Spatial ability to visualize layout of equipment for entire electronic data-processing system to place it into allocated spaces, to design most effective configuration for

effective utilization and repair, and to prepare sketches and drawings of electronic data-processing installations.

Clerical perception to perceive pertinent detail in verbal or tabular material, to avoid or detect errors in compiling various types of narrative materials as reports and recommendations, or reviewing those prepared by others.

Interests:

Interest in activities technical in nature, to understand computer systems and their application to business and industrial problems and to read technical literature.

A preference for business contacts with people to exchange information with management and users of computer systems.

Temperaments:

Requires ability to deal tactfully with people, such as corporate managers, managers and supervisors of computer processing units, and manufacturers, to discuss problems and obtain information.

Required to make judgmental decisions in selecting most suitable equipment and determining its layout, based on a comparison of known computer capabilities with the required computer applications.

Physical Activities and Environmental Conditions:

Work is sedentary. Some walking and standing at meetings and in the process of surveying environmental accommodations for equipment layout.

Talking and hearing involved in dealing with management, supervisors, and manufacturers' representatives.

Near visual acuity required in preparing and reviewing reports.

Work is inside.

TAPE LIBRARIAN

1-20.04
(223.387)

Occupational Definition

Classifies, catalogs, and maintains library of reels of magnetic or punched paper tape or decks of magnetic cards or punchcards used for electronic data-processing purposes: Classifies and catalogs material according to content, purpose of program, routine or subroutine, and date on which generated. Assigns code conforming with standardized system. Prepares index cards for file reference. Stores materials and records according to classification and catalog number. Issues materials and maintains charge-out records. Inspects returned tapes or cards and notifies supervisor if worn or damaged. May maintain files of program developmental records and operating instructions (run books). May operate key-punch to replace defective punchcards and produce data cards to identify punchcard decks. May work in computer room performing such tasks as loading and removing printout forms, reels of tape, and decks of cards from machines.

Education, Training, and Experience

High school graduate, preferably with commercial background. Three to six months' experience as catalog clerk, file clerk, mail clerk, or messenger with the company is desirable.

Special Characteristics

Aptitudes:

Verbal ability to read information on labels describing contents of decks of cards and reels of tape and read catalogs that contain standardized codes and abbreviations.

Numerical ability to count, add, and subtract numbers to perform inventory functions.

Clerical perception to note pertinent detail on labels, cards, or work schedules, and in code books to detect error and avoid misinterpretation.

Interests:

A preference for working with things and objects, following routine and organized patterns to classify, catalog, store, and fill requests for cards and tapes.

Temperaments:

Follows specific instructions and established procedures to receive, store, issue, and purge materials.

Physical Activities and Environmental Conditions:

Work is light, involving frequent standing and walking to carry reels of tapes or trays and drawers of cards weighing less than 20 pounds between desk, handtruck, file cabinets, and racks.

Reaches for and handles tapes and cards to store them.

Near visual acuity to read and assign identification symbols and inspect materials for damage.

Work is performed inside.

VERIFIER OPERATOR

1-25.66
(213.588)

Occupational Definition

Verifies accuracy of data punched on tabulating cards, using keyboard-type machine that rejects incorrectly punched cards: Places punched cards in machine. Depresses keys in same sequence required to punch cards. Removes incorrectly punched cards as indicated by light or by key that will not depress. May punch corrected card, using key-punch machine.

Education, Training, and Experience

High school graduate with demonstrated proficiency in typing. High school or business school training in key-punch operations is desirable.

Special Characteristics

Aptitudes:

Verbal ability to understand oral and written instructions, such as manufacturer's operating manuals to learn operation of machine, and to perform daily assignments.

Clerical perception to perceive pertinent detail in tabular material consisting of letters and numbers.

Motor coordination to read work sheets and simultaneously operate keyboard of verifier.

Interests:

Preference for organized, routine activities to continuously operate verifier machine.

Temperaments:

Work situation requires worker to perform repetitive tasks using verifier machine. Must follow specific instructions to verify punched cards.

Works to precise and established standards of accuracy.

Physical Activities and Environmental Conditions:

Work is sedentary with infrequent lifting of decks of cards when loading machine.

Reaches for and handles code sheets, records, and decks of cards.

Near visual acuity to read copy.

Work is performed inside.

GLOSSARY

A

ACCESS TIME: (1) The time it takes a **COMPUTER** to locate data or an **INSTRUCTION** word in its **STORAGE** section and transfer it to its arithmetic unit where the required computations are performed. (2) The time it takes to transfer information which has been operated on from the arithmetic unit to the location in **STORAGE** where the information is to be stored.

ALPHABETIC-NUMERIC: The characters which include letters of the alphabet, numerals, and other symbols, such as punctuation or mathematical symbols.

ALPHANUMERIC: A contraction of **ALPHABETIC-NUMERIC**.

ANALOG COMPUTER: A **COMPUTER** which represents variables by physical analogies, thus any **COMPUTER** which solves problems by translating physical conditions, such as flow, temperature, pressure, angular position, or voltage, into related mechanical or electrical quantities and uses mechanical or electrical equivalent circuits as an analog for the physical phenomenon being investigated. In general it is a **COMPUTER** which uses an analog for each variable and produces analogs as **OUTPUT**. Thus, an **ANALOG COMPUTER** measures continuously, whereas a **DIGITAL COMPUTER** counts discretely.

ANALOG DATA: Data represented in a continuous form as contrasted with *digital data* represented in a discrete (discontinuous) form. **ANALOG DATA** usually is represented by means of physical variables, such as voltage, resistance, rotation, etc.

APPLICATION STUDY: The detailed process of determining a system or set of procedures for using a **COMPUTER** for definite functions or operations, and establishing specifications to be used as a base for the selection of equipment suitable to the specific needs.

AUTOMATIC DATA PROCESSING (ADP): **DATA PROCESSING** performed by a system of **ELECTRONIC** or electrical machines so interconnected and interacting as to reduce to a minimum the need for human assistance or intervention.

AUTOMATIC DATA-PROCESSING EQUIPMENT: A machine or group of interconnected machines, consisting of **INPUT**, **STORAGE**, computing, control, and **OUTPUT** devices, which uses **ELECTRONIC** circuitry in the main computing element to perform arithmetic and/or logical operations automatically by means of internally stored or externally controlled **PROGRAMED** instructions.

AUTOMATIC DATA-PROCESSING SYSTEM: The term descriptive of an interacting assembly of procedures, processes, methods, personnel, and **AUTOMATIC DATA-PROCESSING EQUIPMENT** to perform a complex series of data-processing operations.

AUTOMATION: Production by devices or machines which are self-acting with respect to predetermined processes, e.g., making automatic the process of moving work from one machine to the next.

B

BATCH PROCESSING: A technique by which items to be processed must be coded and collected into groups prior to processing.

BINARY: A characteristic, property, or condition in which there are but two possible alternatives, e.g., the BINARY number system using 2 as its base and using only the DIGITS zero (0) and one (1).

BINARY CODE: A system of notation consisting of 1's and 0's to represent letters or DIGITS in a COMPUTER.

BIT: (1) An abbreviation of BINARY DIGIT. (2) A single CHARACTER in a BINARY number. (3) A single PULSE in a group of PULSES. (4) A unit of information capacity of a STORAGE device.

BLOCK DIAGRAM: (1) A graphical representation of the HARDWARE in a COMPUTER system. The primary purpose of a BLOCK DIAGRAM is to indicate the paths along which information and/or control flows between the various parts of a COMPUTER system. It should not be confused with the term FLOW CHART. (2) A coarser and less symbolic representation than FLOW CHART.

BOOLEAN ALGEBRA: A process of reasoning, or a deductive system of theorems using a symbolic logic, and dealing with classes, propositions, or on-off circuit elements. It employs symbols to represent operators, such as *and*, *or*, *not*, *except*, *if * * ** *then*, etc. to permit mathematical calculation. Named after George Boole, famous English mathematician (1815-64).

C

CARD READER: (1) A device that SENSES information punched into cards. (2) An INPUT device consisting of a mechanical punchcard reader and related electronic circuitry which transcribes data from punchcards to working STORAGE or MAGNETIC TAPE.

CHARACTER: Any symbol, such as a DIGIT or letter, that is stored or processed by a COMPUTER.

CHARACTER READER: An INPUT device which reads printed CHARACTERS directly from a document.

CHARACTER RECOGNITION: The act of reading, identifying, and encoding a printed CHARACTER by optical or other means.

CHECK: A process of partial or complete testing of the correctness of machine operations, the existence of certain prescribed conditions within the COMPUTER, or the correctness of the results produced by a PROGRAM. A check of any of these conditions may be made automatically by the equipment or may be PROGRAMED.

CLEAR: To erase the contents of a STORAGE device by replacing the contents with blanks, or zeros.

CLOSED LOOP: A group of INSTRUCTIONS which are repeated indefinitely.

CODE: (1) A system of symbols for representing data or INSTRUCTIONS in a COMPUTER or a tabulating machine. (2) To translate the PROGRAM for the solution of a problem on a given COMPUTER into a sequence of machine language or PSEUDO INSTRUCTIONS and addresses acceptable to that COMPUTER.

COMPUTER: An ELECTRONIC device capable of accepting information, performing mathematical and logical operations on it, and reporting the results.

CONFIGURATION: A group of machines which are interconnected and are PROGRAMED to operate as a system.

CONSOLE: A portion of the COMPUTER which may be used to control the machine manually, correct errors, determine the status of machine circuits, registers, and counters, determine the contents of STORAGE, and manually revise the contents of STORAGE.

CONSTANT: A fixed or invariable value or data item.

CONVERTER: A machine that changes information from one form of COMPUTER language to another; as for example, changing the information contained on punchcards to the same information on a magnetic tape.

CYBERNETICS: The study of control and communication theory in machines and humans to eventually substitute self-regulating machines for human controls.

D

DATA PROCESSING: (1) The preparation of source media which contain data or basic elements of information, and the handling of such data according to precise rules of procedure to accomplish such operations as classifying, sorting, calculating, summarizing, and recording. (2) The production of records and reports.

DEBUG: To diagnose and correct COMPUTER malfunctioning or mistakes in PROGRAMING.

DECISION: The COMPUTER operation of determining if a certain relationship exists between words in STORAGE or registers, and taking alternative courses of action. This is effected by conditional jumps or equivalent techniques. Use of this term has given rise to the misnomer "magic brain." Actually, the process consists of making comparisons by use of arithmetic to determine the relationship of two terms (numeric, alphabetic, or a combination of both), e.g., equal, greater than, or less than.

DIAGRAM: (1) A schematic representation of a sequence of SUBROUTINES designed to solve a problem. (2) A coarser and less symbolic representation than a FLOW CHART, frequently including descriptions in English words. (3) A schematic or logical drawing showing the electrical circuit or logical arrangements within a component.

DIGIT: A sign or symbol used to convey a specific quantity of information either by itself or with other numbers of its set, e.g., 2, 3, 4, and 5 are DIGITS.

DIGITAL COMPUTER: A COMPUTER which processes information represented by combinations of discrete or discontinuous data as compared with ANALOG COMPUTER for continuous data.

DOWN-TIME: The period during which a COMPUTER is malfunctioning or not operating correctly due to mechanical or ELECTRONIC failure as opposed to available time, idle time, or standby time, during which the COMPUTER is functional.

E

ELECTRICAL ACCOUNTING MACHINES: The set of conventional punch-card equipment including sorters, collators, and tabulators.

ELECTRONIC: Pertaining to that branch of science which deals with the motion, emission, and behavior of currents of free electrons, especially in vacuum, gas, or phototubes and special conductors or semi-conductors. This is contrasted with *electric* which pertains to the flow of large currents in metal containers.

ELECTRONIC DATA PROCESSING: DATA PROCESSING performed largely by ELECTRONIC equipment.

ELECTRONIC DATA-PROCESSING EQUIPMENT: See AUTOMATIC DATA-PROCESSING EQUIPMENT.

ELECTRONIC DATA-PROCESSING SYSTEM: The general term used to define a system for DATA PROCESSING by means of machines utilizing ELECTRONIC circuitry at ELECTRONIC speed as opposed to electromechanical equipment.

ERROR: The extent to which precision is lost in a given quantity or the difference between a quantity and its calculated approximation.

F

FEASIBILITY STUDY: A study undertaken to identify various areas of operation within an organization which appear to be susceptible to AUTOMATIC DATA

PROCESSING so as to determine the possible impact of ADP within these areas in terms of operating economies or improved management efficiency.

FEEDBACK: The use of part of the **OUTPUT** of a machine, process, or system as **INPUT** for another phase, especially for self-correcting or control purposes.

FLOW CHART: A graphic representation of the major steps of work in process. The illustrative symbols may represent documents, machines, or actions taken during the process. Also known as *process chart*.

FORTRAN: A PROGRAMING language designed for problems which can be expressed in algebraic notation.

G

GAME THEORY: A mathematical process of selecting an optimum strategy in the face of any opponent who has a strategy of his own.

H

HARDWARE: The physical equipment or devices forming a **COMPUTER** and **PERIPHERAL EQUIPMENT**. Contrasted with **SOFTWARE**.

I

INFORMATION: A collection of facts or other data, especially as derived from the processing of data.

INFORMATION RETRIEVAL: The recovering of desired information or data from a collection of documents or other graphic records.

INFORMATION RETRIEVAL SYSTEM: A system for locating and selecting, on demand, certain documents, or other graphic records relevant to a given information requirement from a file of such material. Examples of **INFORMATION RETRIEVAL SYSTEMS** are classification, indexing, and machine searching systems.

INPUT: Information transferred from auxiliary or external **STORAGE** into internal **STORAGE**.

INSTRUCTION: A set of **COMPUTER** words or characters that define the operation to be performed by a **COMPUTER**.

L

LIBRARY: A set or collection of standardized **PROGRAMS** by which frequently occurring types of problems may be solved. The library may be cataloged according to the type of arithmetical operation employed.

LOGIC: (1) The science dealing with the criteria or formal principles of reasoning and thought. (2) The systematic scheme which defines the interactions of signals in the design of an **AUTOMATIC DATA-PROCESSING SYSTEM**. (3) The basic principles and application of truth tables and interconnection between logical elements required for arithmetic computation in an **AUTOMATIC DATA-PROCESSING SYSTEM**.

LOOP: A coding technique in which a group of **INSTRUCTIONS** are repeated, usually with modified **INSTRUCTIONS** or modified data values.

M

MACHINE ERROR: A deviation from correctness in data resulting from an equipment failure.

MACHINE LANGUAGE: See **MACHINE-ORIENTED LANGUAGE**.

MACHINE-ORIENTED LANGUAGE: (1) A language designed for interpretation and use by a machine without translation. (2) A system for expressing infor-

mation which is intelligible to a specific machine, e.g., a **COMPUTER** or class of **COMPUTERS**. Such a language may include **INSTRUCTIONS** which define and direct machine operations, and information to be recorded by or acted upon by these machine operations.

MAGNETIC DISK: A **STORAGE** device on which information is recorded on the magnetizable surface of a rotating disk. A **MAGNETIC DISK STORAGE** system is an array of such devices, with associated reading and writing heads which are mounted on movable arms.

MAGNETIC DRUM: A cylinder having a surface coating of magnetic material, which stores **BINARY** information by the orientation of magnetic dipoles near or on its surface. Since the drum is rotated at a uniform rate, the information stored is available periodically as a given portion of the surface moves past one or more flux-detecting devices called *heads* located near the surface of the drum.

MAGNETIC TAPE: A continuous flexible recording medium whose base material is impregnated or coated with a magnetic sensitive material ready to accept data in the form of magnetically polarized spots.

MATHEMATICAL MODEL: The general characterization of a process, object, or concept, in terms of mathematics, which enables the relatively simple manipulation of variables to be accomplished in order to determine how the process, object, or concept would behave in different situations.

MEMORY: See **STORAGE**.

MNEMONIC CODE: A technique to assist the human memory. A **MNEMONIC CODE** resembles the original word and is usually easy to remember, e.g. *mpy* for multiply and *acc* for accumulator.

MODULE: (1) An interchangeable plug-in item containing components. (2) An incremental block of **STORAGE** or other building block for expanding the **COMPUTER** capacity.

N

NOISE: Meaningless extra **BITS** or words which must be ignored or removed from the data at the time the data are used.

O

OFF-LINE: Pertaining to the operation of **INPUT-OUTPUT** devices or auxiliary equipment not under direct control of the central processing unit.

ON-LINE: Pertaining to the operation of **INPUT-OUTPUT** devices under direct control of the central processing unit.

OPERATIONS RESEARCH: The use of analytic methods adopted from mathematics for solving operational problems. The objective is to provide management with a more logical basis for making sound predictions and decisions. Among the common scientific techniques used in **OPERATIONS RESEARCH** are the following: linear programming, **PROBABILITY THEORY**, information theory, **GAME THEORY**, Monte Carlo method, and **QUEUEING** theory.

OPTICAL SCANNER: A device that automatically samples or verifies a number of measuring points and indicates those that have drifted from their desired values.

ORDER: (1) A defined successive arrangement of elements or events. This term is losing favor as a synonym for **INSTRUCTIONS**, due to ambiguity. (2) To sequence or arrange in a series. (3) The weight or significance assigned to a **DIGIT** position in a number.

OUTPUT: Information transferred from internal **STORAGE** to external **STORAGE** or to an **ON-LINE** output device.

OVERFLOW: (1) The condition which arises when the result of an arithmetic operation exceeds the capacity of the STORAGE space allotted in a DIGITAL COMPUTER. (2) The DIGIT arising from this condition if a mechanical or PROGRAMED indicator is included, otherwise the DIGIT may be lost.

P

PAPER TAPE: A strip of paper capable of storing or recording information. Storage may be in the form of punched holes, partially punched holes, carbonization or chemical change of impregnated material, or by imprinting. Some paper tapes, such as punched paper tapes, are capable of being read by the INPUT device of a COMPUTER or a transmitting device by SENSING the pattern of holes which represent coded information.

PARAMETER: (1) A quantity in a SUBROUTINE, whose value specifies or partly specifies the process to be performed. It may be given different values when the SUBROUTINE is used in different main ROUTINES or in different parts of one main ROUTINE, but usually remains unchanged throughout any one such use. (2) A quantity used in a generator to specify machine CONFIGURATION, designate SUBROUTINES to be included, or otherwise to describe the desired ROUTINE to be generated. (3) A constant or a variable in mathematics which remains fixed during some calculation. (4) A definable characteristic of an item, device, or system.

PATCHBOARD: A component of some DATA-PROCESSING machines which permits the expression of instructions in a semifixed COMPUTER program by the insertion of pins, plugs, or wires into sockets or hubs in the components in a pattern to represent instructions, thus making electrical interconnections which may be sensed by the DATA-PROCESSING machine.

PERIPHERAL EQUIPMENT: The auxiliary machines not under the control of the central COMPUTER.

PLUGBOARD: See PATCHBOARD.

POST MORTEM ROUTINE: A technique used to assist in locating coding errors. It is a procedure that automatically or on demand prints information concerning the contents of the registers at the time the operation stopped.

PROBABILITY THEORY: A measure of likelihood of occurrence of a chance event, used to predict behavior of a group, not of a single item in the group.

PROCESS CHART: See FLOW CHART.

PROGRAM: (1) The complete plan for the solution of a problem, more specifically the complete sequence of machine INSTRUCTIONS and ROUTINES necessary to solve a problem. (2) To plan the procedures for solving a problem. This may involve among other things the analysis of the problem, preparation of a flow DIAGRAM, preparing details, testing, and developing SUBROUTINES, allocation of STORAGE locations, specification of INPUT and OUTPUT formats, and the incorporation of a COMPUTER RUN into a complete DATA-PROCESSING system.

PSEUDO INSTRUCTION: (1) A symbolic representation in a compiler or interpreter. (2) A group of characters having the same general form as a COMPUTER INSTRUCTION, but never executed by the COMPUTER as an actual INSTRUCTION.

PULSE: A significant, and sudden change of short duration in the level of some electric variable, usually voltage.

PUNCHTAPE: A tape, usually paper, upon which data may be stored in the form of punched holes. Hole locations are arranged in columns across the width of the tape. There usually are five to eight positions or channels, per column, with data represented by a BINARY coded decimal system. All holes in a column are SENSED simultaneously in a manner similar to that for punchcards.

Q

QUEUING: A study of the patterns involved and the time required for discrete units to move through channels, e.g., the elapsed time for automobile traffic at a toll booth or employees in a cafeteria line.

R

RANDOM ACCESS STORAGE: (1) A STORAGE technique in which the time required to obtain information is statistically independent of the location of the information most recently obtained. (2) A type of STORAGE in which access can be made directly to any STORAGE location regardless of its position, either absolute or relative to the previously referenced information.

READ: To copy information from one form of STORAGE to another or to SENSE the meaning of stored information.

REAL-TIME OPERATION: Concurrent operations for DATA PROCESSING (computing) and physical processing in such a way that the results of the computing operations are available whenever needed by the physical processing operations, and vice versa.

RETRIEVAL: See INFORMATION RETRIEVAL.

ROUTINE: A set of coded INSTRUCTIONS arranged in proper sequence to direct the COMPUTER to perform a desired operation or sequence of operations. A subdivision of a PROGRAM consisting of two or more INSTRUCTIONS that are functionally related; therefore, a PROGRAM.

RUN: The performance of one PROGRAM on a COMPUTER, thus the performance of one ROUTINE or several ROUTINES linked so that they form an automatic operating unit, during which manual manipulations by the COMPUTER operator are zero or at least minimal.

S

SENSE: To read punched holes or other marks.

SERVOMECHANISM: A device to monitor an operation as it proceeds, and make necessary adjustments to keep the operation under control. A furnace thermostat is an example.

SOFTWARE: PROGRAMS and ROUTINES used to extend the capabilities of COMPUTERS, such as compilers, narrators, ROUTINES, and SUBROUTINES.

SOLID STATE: The ELECTRONIC components that convey or control electrons within solid materials, e.g., TRANSISTORS, germanium diodes, and magnetic cores. Thus vacuum and gas tubes are not included.

STORAGE: (1) The term preferred to *memory*. (2) Pertaining to a device in which data can be stored and from which it can be obtained at a later time. The means of storing data may be chemical, electrical, or mechanical. (3) A device consisting of ELECTRONIC, electrostatic, electrical, HARDWARE or other elements into which data may be entered and from which data may be obtained as desired. (4) The erasable data in any given COMPUTER.

SUBROUTINE: (1) The set of INSTRUCTIONS necessary to direct the COMPUTER to carry out a well-defined mathematical or logical operation. (2) A subunit of a ROUTINE. A SUBROUTINE is often written in relative or symbolic coding even when the ROUTINE to which it belongs is not. (3) A portion of a ROUTINE that causes a COMPUTER to carry out a well-defined mathematical or logical operation. (4) A ROUTINE which is arranged so that control may be transferred to it from a master ROUTINE and so that, at the conclusion of the SUBROUTINE, control reverts to the master ROUTINE. Such a SUBROUTINE is usually called a closed

ROUTINE. (5) A single **ROUTINE** may simultaneously be both a **SUBROUTINE** with respect to another **ROUTINE** and a master **ROUTINE** with respect to a third. Usually control is transferred to a single **SUBROUTINE** from more than one place in the master **ROUTINE** and the reason for using the **SUBROUTINE** is to avoid having to repeat the same sequence of **INSTRUCTIONS** in different places in the master **ROUTINE**.

T

TRANSISTOR: An **ELECTRONIC** device utilizing semiconductor properties to control the flow of currents.

V

VARIABLE QUANTITY: A quantity that may assume a succession of values.

VERIFIER: A device that automatically compares (verifies) the **CHARACTERS** on a manual transcription against retranscription.

W

WORD: An ordered set of **CHARACTERS** which occupies one **STORAGE** location and is treated by the **COMPUTER** circuits as a unit and transferred as such. Ordinarily, a **WORD** is treated by the control unit as an **INSTRUCTION**, and by the arithmetic unit as a quantity. **WORD** lengths may be fixed or variable, depending on the particular **COMPUTER**.

WORKER TRAITS

APTITUDES:

1. **VERBAL.**—Ability to understand meanings of words and ideas associated with them, and to use them effectively; to comprehend language, to understand relationships between words, and to understand meanings of whole sentences and paragraphs; to present information or ideas clearly.

2. **NUMERICAL.**—Ability to perform arithmetic operations quickly and accurately.

3. **SPATIAL.**—Ability to comprehend forms in space and understand relationships of plane and solid objects. May be used in such tasks as blueprint reading and in solving geometry problems. Frequently described as the ability to “visualize” objects of two or three dimensions, or to think visually of geometric forms.

4. **FORM PERCEPTION.**—Ability to perceive pertinent detail in objects or in pictorial or graphic material. To make visual comparisons and discriminations and see slight differences in shapes and shadings of figures and widths and lengths of lines.

5. **CLERICAL PERCEPTION.**—Ability to perceive pertinent detail in verbal or tabular material. To observe differences in copy, to proofread words and numbers and to avoid perceptual errors in arithmetic computation.

6. **MOTOR COORDINATION.**—Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and quickly.

7. **FINGER DEXTERITY.**—Ability to move the fingers and manipulate small objects with the fingers rapidly or accurately.

8. **MANUAL DEXTERITY.**—Ability to move the hands easily and skillfully. To work with the hands in placing and turning motions.

9. **EYE-HAND-FOOT COORDINATION.**—Ability to move the hand and foot coordinately with each other in accordance with visual stimuli.

10. **COLOR DISCRIMINATION.**—Ability to perceive or recognize similarities or differences in colors, or in shades or other values of the same color; to identify a particular color, or to recognize harmonious or contrasting color combinations, or to match colors accurately.

11. **INTELLIGENCE.**—General learning ability. The ability to “catch on” or understand instructions and underlying principles. Ability to reason and make judgments. Closely related to doing well in school.

INTERESTS:

1. Situations involving a preference for activities dealing with Things and Objects. *vs.*

2. Situations involving a preference for activities involving Business Contact with People. *vs.*

3. Situations involving a preference for activities of a Routine, Concrete, Organized nature. *vs.*

6. Situations involving a preference for activities concerned with People and the Communication of Ideas.

7. Situations involving a preference for activities of a Scientific and Technical nature.

8. Situations involving a preference for activities of an Abstract and Creative nature.

4. Situations involving a preference for Working for People for their presumed good as in the Social Welfare sense, or for dealing with People and Language in Social Situations.

5. Situations involving a preference for activities resulting in Prestige or the Esteem of Others.

vs.

9. Situations involving a preference for activities that are Nonsocial in nature, and are carried on in relation to Processes, Machines, and Techniques.

vs.

0. Situations involving a preference for activities resulting in Tangible, Productive Satisfaction.

TEMPERAMENTS:

1. Situations involving a variety of duties often characterized by frequent change.
2. Situations involving repetitive or short-cycle operations carried out according to set procedures or sequences.

3. Situations involving doing things only under specific instructions, allowing little or no room for independent action or judgment in working out job problems.

4. Situations involving the direction, control, and planning of an entire activity or the activities of others.

5. Situations involving the necessity of dealing with people in actual job duties beyond giving and receiving instructions.

6. Situations involving working alone and apart in physical isolation from others, although activity may be integrated with that of others.

7. Situations involving influencing people in their opinions, attitudes, or judgments about ideas or things.

8. Situations involving performing adequately under stress when confronted with the critical or unexpected or when taking risks.

9. Situations involving the evaluation (arriving at generalizations, standards, or decisions) of information against sensory or judgmental criteria.

0. Situations involving the evaluation (arriving at generalizations, standards, or decisions) of information against measurable or verifiable criteria.

X. Situations involving the interpretation of feelings, ideas, or facts in terms of personal viewpoint.

Y. Situations involving the precise attainment of prescribed limits, tolerances, or standards.

PHYSICAL ACTIVITIES:

1. **LIFTING, CARRYING, PUSHING, AND PULLING.**—These are the primary “strength” physical requirements, and generally speaking, a person who engages in one of these activities can and does engage in all. Specifically, each of these activities can be described as follows:

(1) *Lifting.*—Raising or lowering an object from one level to another; includes upward pulling.

(2) *Carrying.*—Transporting an object, usually holding it in the hands or arms, or on the shoulder.

(3) *Pushing.*—Exerting force upon an object so that the object moves away from the force. This includes slapping, striking, kicking, and treadle actions.

(4) *Pulling.*—Exerting force upon an object so that the object moves toward the force; includes jerking.

The “strength” factor is divided into five categories as follows:

(a) **SEDENTARY.**—Lifting 10 pounds maximum. Includes occasionally lifting and/or carrying docket, ledgers, small tools, and the like. Although a sedentary job is defined as one which involves sitting, a certain amount of walking and standing is often necessary in carrying out job duties. Jobs are called sedentary if walking and standing is required only occasionally and all other sedentary criteria are met.

(b) **LIGHT**.—Lifting 20 pounds maximum with frequent lifting and/or carrying of objects weighing up to 10 pounds. Also, even though the weight lifted may be only a negligible amount, a job is placed in this category when it requires walking or standing to a significant degree; or when it requires sitting most of the time but entails pushing and pulling of arm and/or leg controls.

(c) **MEDIUM**.—Lifting 50 pounds maximum with frequent lifting and carrying of objects weighing up to 25 pounds.

(d) **HEAVY**.—Lifting 100 pounds maximum with frequent lifting and carrying of objects weighing up to 50 pounds.

(e) **VERY HEAVY**.—Lifting objects in excess of 100 pounds with frequent lifting and carrying of objects weighing 50 pounds or more.

2. **CLIMBING AND BALANCING**.—These activities are defined as follows:

(1) *Climbing*.—Ascending or descending ladders, stairs, scaffolding, ramps, poles, ropes, and the like, using the feet and legs alone, or in conjunction with hands and arms.

(2) *Balancing*.—Maintaining body equilibrium to prevent falling when walking, standing, crouching, or running on narrow, slippery, or erratically moving surfaces; or maintaining body equilibrium when performing gymnastic feats.

3. **STOOPING, KNEELING, CROUCHING, AND CRAWLING**.—These activities are defined as:

(1) *Stooping*.—Bending the body downward and forward by bending the spine at the waist.

(2) *Kneeling*.—Bending the legs at the knees to come to rest on the knee or knees.

(3) *Crouching*.—Bending the body downward and forward by bending the legs and spine.

(4) *Crawling*.—Moving about on the hands and knees or hands and feet.

The activities in this factor involve full use of the lower extremities as well as the back muscles. Therefore, stooping is rarely considered when the worker is performing this act while in a sitting position.

4. **REACHING, HANDLING, FINGERING, AND FEELING**.—These activities involve the use of one or both of the upper extremities and are defined as follows:

(1) *Reaching*.—Extending the hands and arms in any direction.

(2) *Handling*.—Seizing, holding, grasping, turning, or otherwise working with the hand or hands; not fingering.

(3) *Fingering*.—Picking, pinching, or otherwise working with the fingers primarily (rather than with the whole hand or arm as in handling).

(4) *Feeling*.—Perceiving such attributes of objects as size, shape, temperature, or texture by means of receptors in the skin, particularly those of the finger tips.

5. **TALKING AND HEARING**.—These activities are defined as follows:

(1) *Talking*.—Expressing or exchanging ideas by means of spoken words. The ability to talk is important for those job-worker situations in which the individual must impart oral information to clients or to the public, and in those situations in which he must convey detailed or important spoken instructions to other employees accurately, loudly, or quickly.

(2) *Hearing*.—Perceiving the nature of sounds by the ear. Hearing is important for those job-worker situations which require the ability to receive detailed information through oral communication, and to make fine discriminations in sounds, such as making fine adjustments on running engines.

6. **SEEING**.—Seeing involves obtaining impressions through the eyes of the shape, size, distance, motion, color, or other characteristics of objects. The major visual functions with respect to occupational analysis are: (1) acuity, far and near; (2) depth perception; (3) field of vision; (4) accommodation; (5) color vision.

The functions are defined as follows:

(1) *Acuity, far*.—Clarity of vision at 20 feet or more.

Acuity, near.—Clarity of vision at 20 inches or less.

(2) *Depth perception*.—Three-dimensional vision. The ability to judge distance and space relationships so as to see objects where and as they actually are.

(3) *Field of vision*.—The area that can be seen up and down or to the right or left while the eyes are fixed on a given point.

(4) *Accommodation*.—Adjustment of the lens of the eye to bring an object into sharp focus. This item is especially important when doing near-point work at varying distances from the eye.

(5) *Color vision*.—The ability to identify and distinguish colors.

ENVIRONMENTAL CONDITIONS:

1. **INSIDE OR OUTSIDE**.—These conditions are defined as follows:

(1) *Inside*.—Protection from weather conditions but not necessarily from temperature changes.

(2) *Outside*.—No effective protection from weather. A job is considered inside if the worker spends approximately 75 percent or more of his time inside; outside if the worker spends approximately 75 percent or more of his time outside. *Inside or Outside* is interpreted as being synonymous with indoors and outdoors.

2. **EXTREMES OF COLD PLUS TEMPERATURE CHANGES**.—These conditions are defined as follows:

(1) *Extremes of Cold*.—Temperature sufficiently low to cause marked bodily discomfort unless the worker is provided with exceptional protection.

(2) *Temperature Changes*.—Variations in temperature which are sufficiently marked and abrupt to cause marked bodily reactions.

3. **EXTREMES OF HEAT PLUS TEMPERATURE CHANGES**.—These conditions are defined as follows:

(1) *Extremes of Heat*.—Temperature sufficiently high to cause marked bodily discomfort unless the worker is provided with exceptional protection.

(2) *Temperature Changes*.—Variations in temperature which are sufficiently marked and abrupt to cause marked bodily reactions.

4. **WET AND HUMID**.—These conditions are defined as follows:

(1) *Wet*.—Contact with water or other liquids.

(2) *Humid*.—Atmospheric condition with moisture content sufficiently high to cause marked bodily discomfort.

5. **NOISE AND VIBRATION**.—For this factor to be considered, there must have been sufficient noise, either constant or intermittent, to cause marked distraction or possible injury to the sense of hearing and/or sufficient vibration (which is the production of an oscillating movement or strain on the body or its extremities from repeated motion or shock) to cause bodily harm if endured day after day.

6. **HAZARDS**.—Conditions or situations in which there is danger to life, health, or of bodily injury. This category includes a variety of physical hazards, such as proximity to moving mechanical parts, electrical shock, working on scaffolding and high places, exposure to burns and radiant energy, exposure to all types of explosives, and exposure to toxic chemical and biological agents. Toxic chemical and biological agents include certain fumes, dusts, mists, gases, bacteria, fungi, and parasites.

7. **ATMOSPHERIC CONDITIONS**.—These conditions affect the respiratory system or the skin. The conditions are described as:

(1) *Fumes*.—Solid particles generated by condensation from the gaseous state, generally after volatilization from molten metals, and often accompanied by a chemical reaction such as oxidation. For example, cadmium, lead, magnesium, manganese, and zinc fumes are toxic and may cause metal fume fever.

(2) *Odors*.—Noxious nontoxic smells.

(3) *Dusts*.—Solid particles, generated by handling, crushing, grinding, rapid impact, detonation, and decrepitation of organic and inorganic materials such as rock, ore, metal, coal, wood, and grain. Toxic dusts include those which may

produce pneumoconiosis, systemic poisoning, dermatoses of primary irritant or allergic nature, and cancer. For example, some ore bodies containing various forms of quartz can be causes of silicosis.

(4) *Mists*.—Suspended liquid droplets generated by condensation from the gaseous to the liquid state or by breaking up a liquid into a dispersed state, such as splashing, foaming, and atomizing. Includes chromic acid mists from electroplating, acid and alkali mists from pickling or electroplating cleaning operations, and oil mists generated from machine tool lubricants and coolants.

(5) *Gases*.—Normally, formless fluids which occupy the space of enclosure and which can be changed to the liquid or solid state only by the combined effect of increased pressure and decreased temperature. Carbon monoxide, hydrogen cyanide, oxides of nitrogen, and ozone are among the gases of significance as industrial hazards.

(6) *Poor Ventilation*.—Insufficient or excessive movement of air causing a feeling of suffocation or exposure to drafts.

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SOURCES OF ADDITIONAL INFORMATION

The organizations, colleges, and universities listed below may be contacted for further academic, technical, or employment information concerning electronic-data-processing activities. This list is not an exhaustive one and is offered as a guide.

ORGANIZATIONS

- American Bankers' Association, 12 East 36th Street, New York, N.Y., 10016
- American Documentation Institute, 1728 N Street NW., Washington, D.C., 20036
- American Federation of Information Processing Societies, Post Office Box 1196, Santa Monica, Calif., 90406
- American Institute of Industrial Engineers, 345 East 47th Street, New York, N.Y., 10017
- American Management Association, 135 West 50th Street, New York, N.Y., 10019
- American Production and Inventory Control Society, 330 South Wells Street, Chicago, Ill., 60606
- American Society of Mechanical Engineers, 345 East 47th Street, New York, N.Y., 10017
- Armed Forces Management Association, 1025 Connecticut Avenue NW., Washington, D.C., 20036
- Army Finance Association, Post Office Box 793, Alexandria, Va., 22313
- Association for Computing Machinery, 211 East 43d Street, New York, N.Y., 10017
- Association of Consulting Management Engineers, 347 Madison Avenue, New York, N.Y., 10017
- Association of Data Processing Service Organizations, 947 Old York Road, Abington, Pa., 19001
- Business Equipment Manufacturers' Association, Data Processing Group, 235 East 42d Street, New York, N.Y., 10017
- Data Processing Management Association, 524 Busse Highway, Park Ridge, Ill., 60068
- Federal Government Accountants' Association, 1523 L Street NW., Washington, D.C., 20005
- Financial Executives' Institute, 50 West 44th Street, New York, N.Y., 10036
- Industrial Management Society, 330 South Wells Street, Chicago, Ill., 60606
- *Institute of Electrical and Electronic Engineers, 345 East 47th Street, New York, N.Y., 10017
- Institute of Management Sciences, 250 North, White Plains, N.Y., 10605
- International Management Association, 1515 Broadway, New York, N.Y., 10036
- Life Office Management Association, 757 Third Avenue, New York, N.Y., 10017
- National Association of Accountants, 505 Park Avenue, New York, N.Y., 10022
- National Association of Credit Management, 44 East 23d Street, New York, N.Y., 10010
- National Association of Manufacturers, 2 East 48th Street, New York, N.Y., 10017
- National Machine Accountants' Association, 1750 West Central Road, Mount Prospect, Ill., 60056
- National Management Association, 333 West First Street, Dayton, Ohio, 45402

*American Institute of Electrical Engineers and American Institute of Radio Engineers, listed in the 1959 brochure, have been merged into the Institute of Electrical & Electronic Engineers.

National Office Management Association, Willow Grove, Pa., 19090
 National Referral Center for Science and Technology, Library of Congress, Washington, D.C., 20540
 National Retail Merchants' Association, 100 West 31st Street, New York, N.Y., 10001
 Operations Research Society of America, Mount Royal and Guilford Avenue, Baltimore, Md., 21202
 Railway Systems & Management Associ-

ation, 163 East Walton Street, Chicago, Ill., 60611
 Simulation Councils, Inc., Post Office Box 2228, La Jolla, Calif., 92038
 Society for the Advancement of Management, Inc., 16 West 40th Street, New York, N.Y., 10018
 Systems & Procedures Association of America, 7890 Brookside Drive, Cleveland, Ohio, 44138
 U.S. Chamber of Commerce, 1615 H Street NW., Washington, D.C., 20006

COLLEGES AND UNIVERSITIES

Auburn University, Auburn, Ala.
 Brown University, Providence, R.I.
 California Institute of Technology, Pasadena, Calif.
 Carnegie Institute of Technology, Pittsburgh, Pa.
 Columbia University, New York, N.Y.
 Cornell University, Ithaca and New York City, N.Y.
 Dartmouth College, Hanover, N.H.
 Georgia Institute of Technology, Atlanta, Ga.
 Harvard University, Cambridge, Mass.
 Illinois Institute of Technology, Chicago, Ill.
 Johns Hopkins University, Baltimore, Md.
 Kansas State College, Manhattan, Kans.
 Massachusetts Institute of Technology, Cambridge, Mass.
 Michigan State University, East Lansing, Mich.
 Northwestern University, Evanston and Chicago, Ill.
 Ohio State University, College of Engineering, Columbus, Ohio

Purdue University, Lafayette, Ind.
 Southern Methodist University, Dallas, Tex.
 Stanford University, Stanford, Calif.
 University of California at Los Angeles, Los Angeles, Calif.
 University of California, Berkeley, Calif.
 University of Chicago, Chicago, Ill.
 University of Illinois, Urbana-Champaign, Ill.
 University of Michigan, Ann Arbor, Mich.
 University of Missouri, Columbia, Mo.
 University of Pennsylvania, Philadelphia, Pa.
 University of Pittsburgh, Pittsburgh, Pa.
 University of Rochester, Rochester, N.Y.
 University of Virginia, Charlottesville, Va.
 University of Washington, Seattle, Wash.
 University of Wisconsin, Madison, Wis.
 Washington University, Department of Computer Sciences, St. Louis, Mo.
 Wayne University, Detroit, Mich.

INDEX OF OCCUPATIONAL TITLES

The titles listed, all in alphabetical order, are presented in three forms:

All capital letters—main titles identifying the job.

All lowercase letters—alternate or synonym titles, by which a job is also known.

Initial capital letters—related titles. These are self-descriptive variations of the jobs they are associated with.

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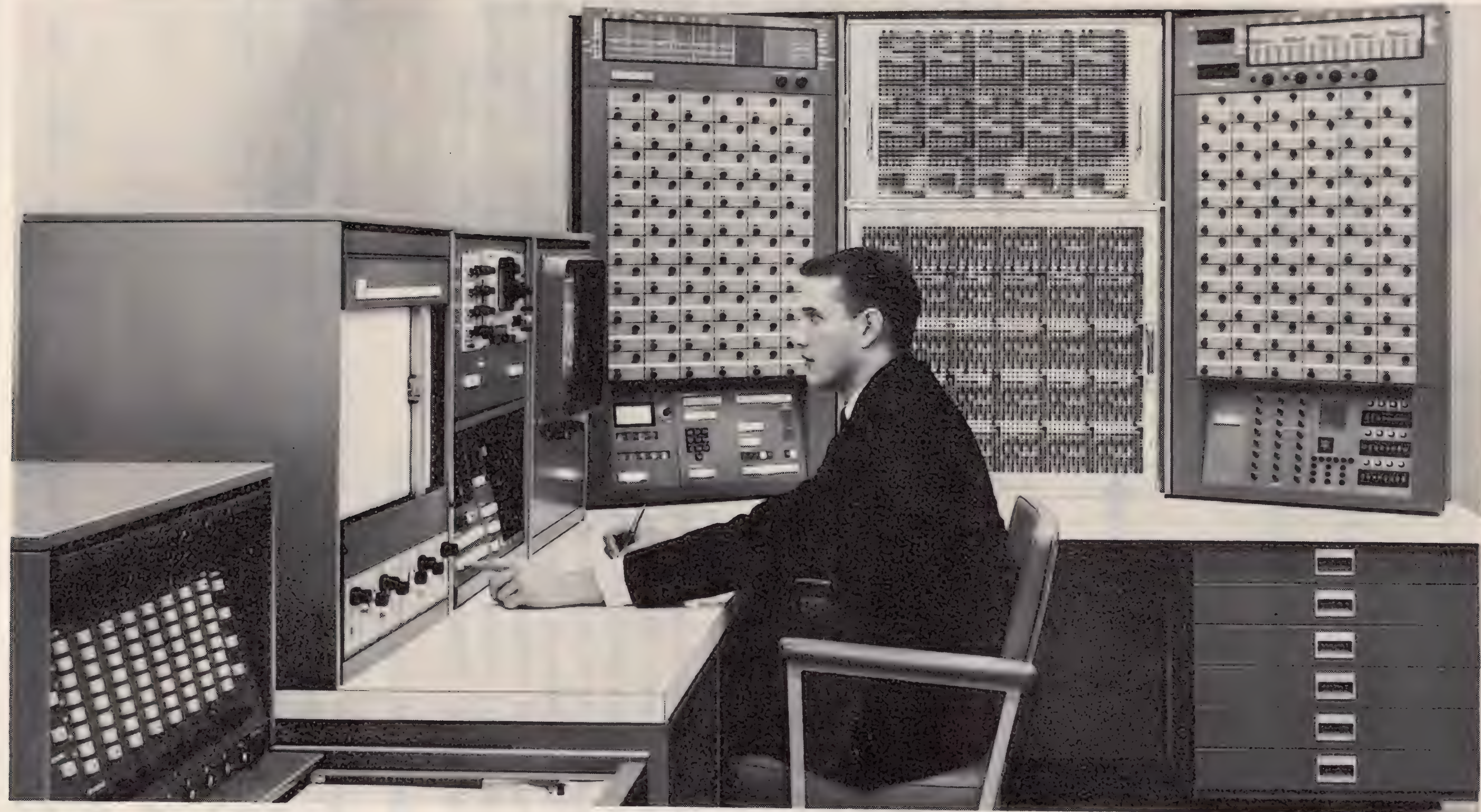
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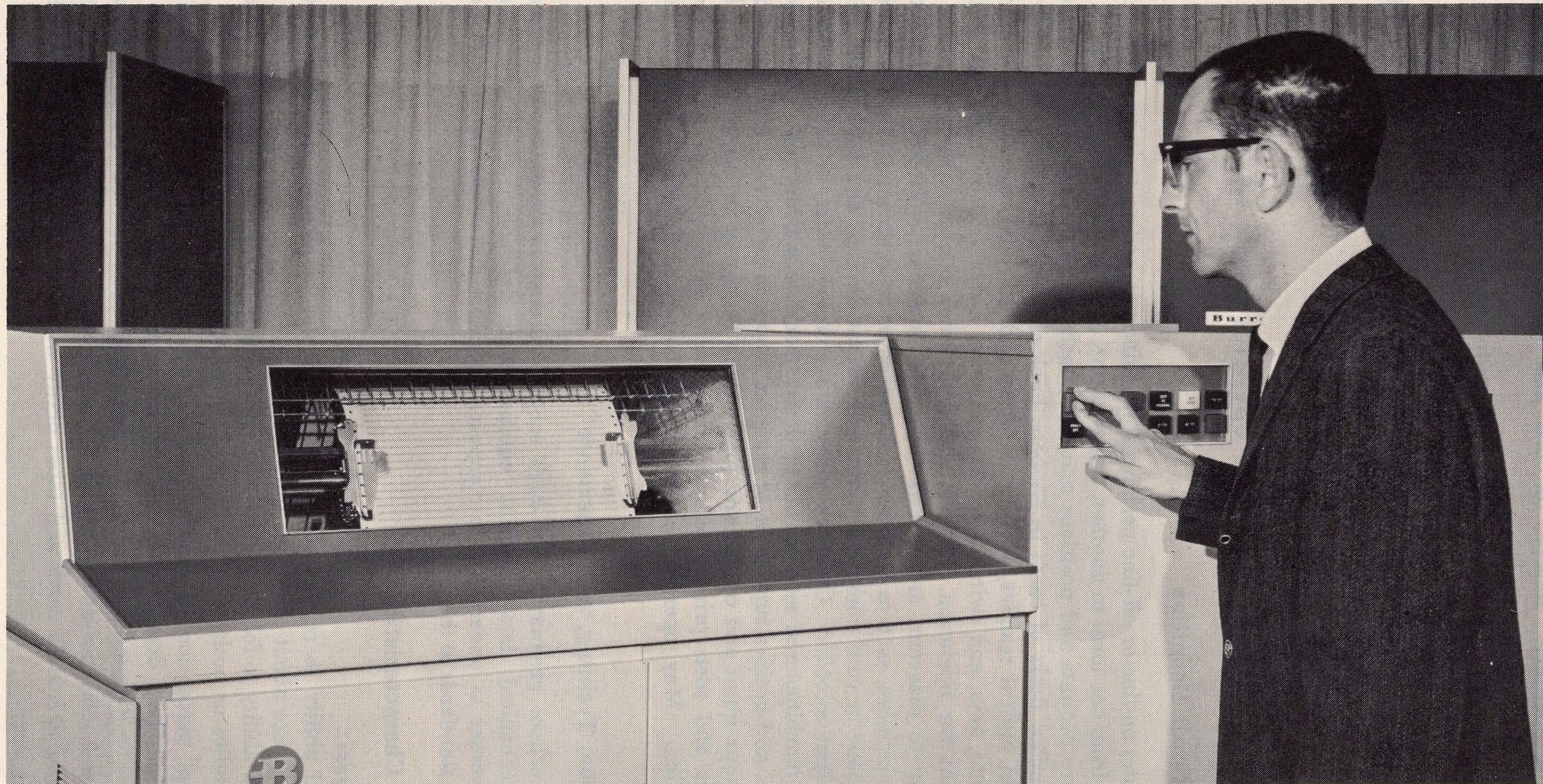
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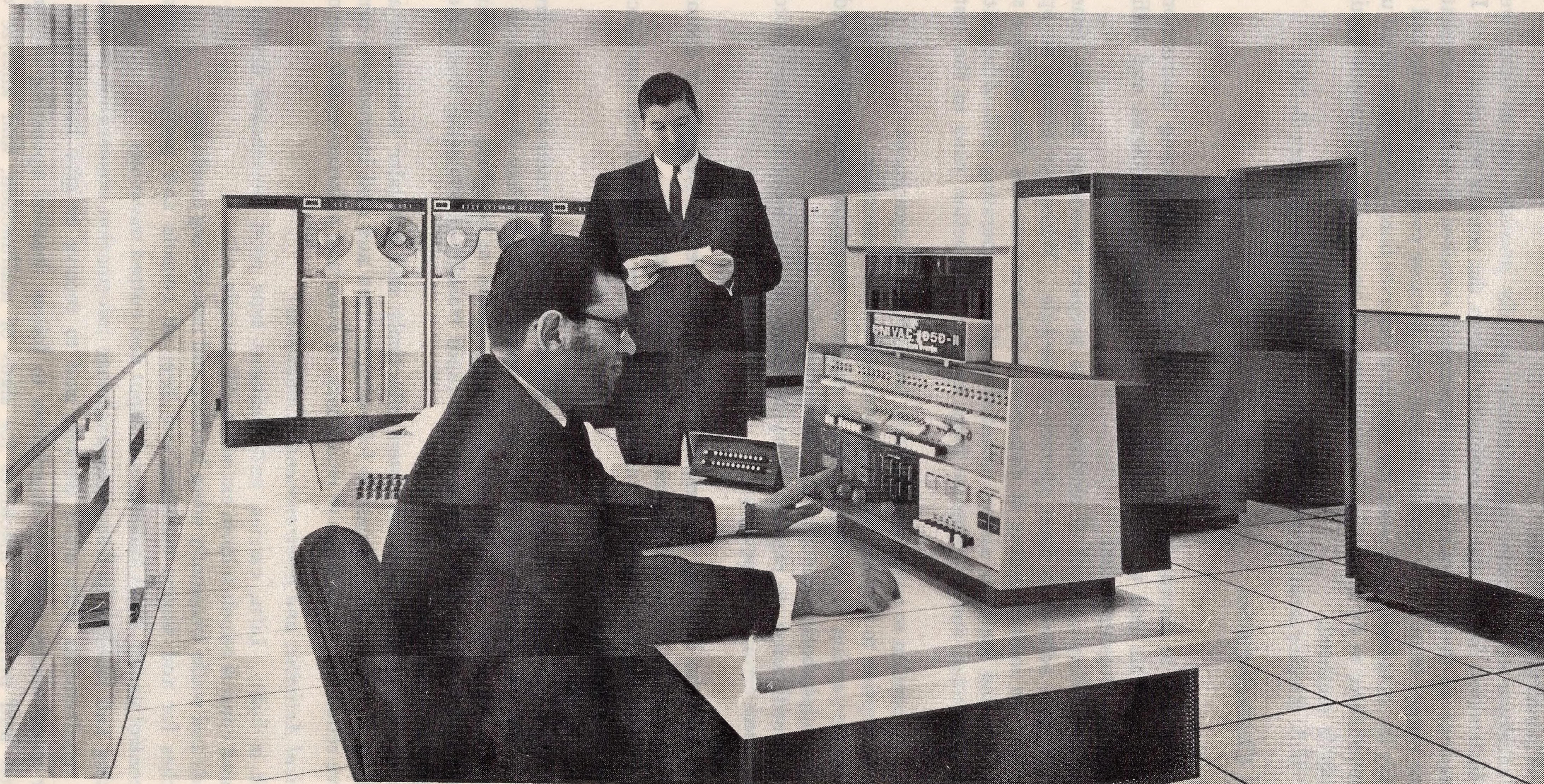
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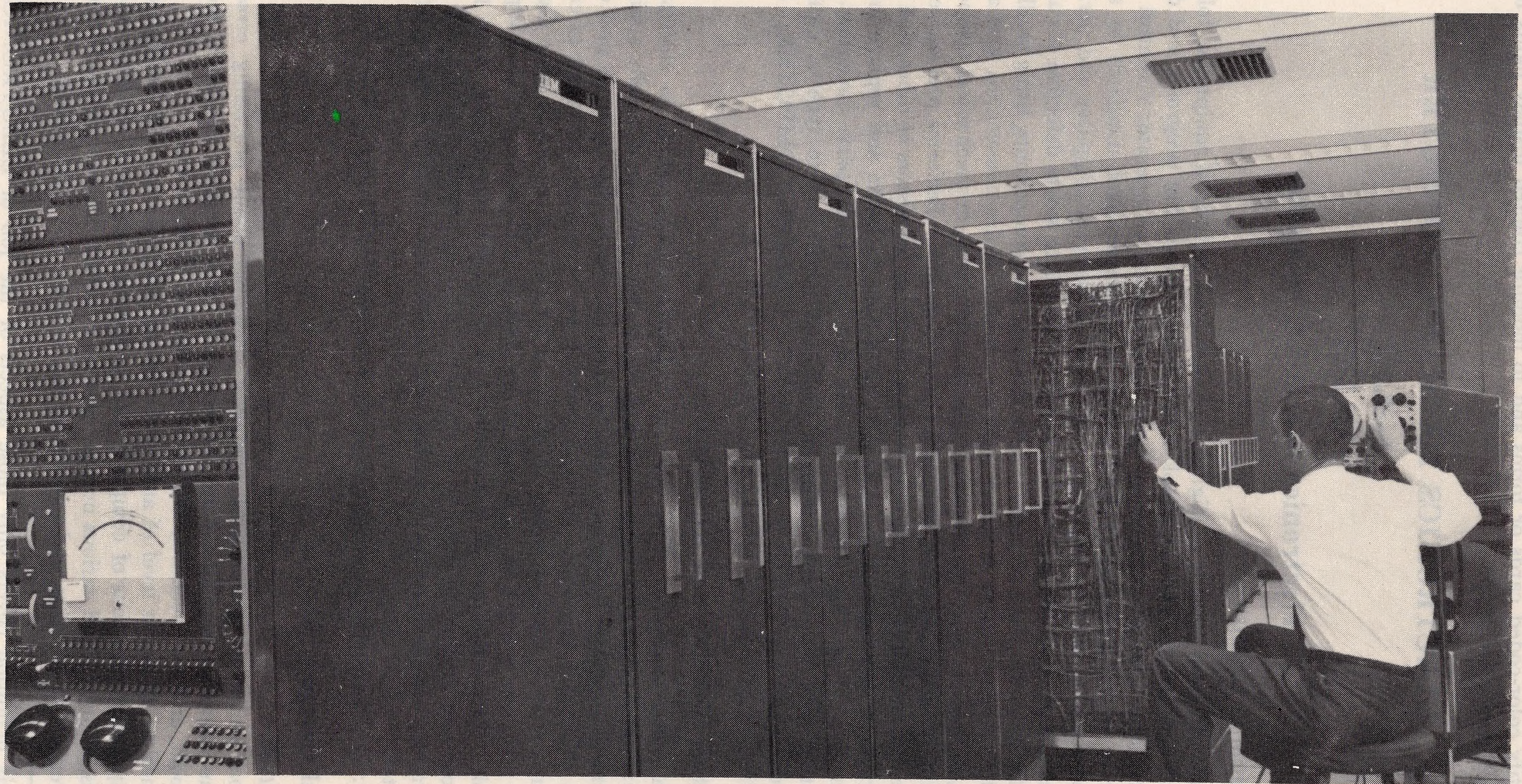
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DIGITAL-COMPUTER OPERATOR AT CONSOLE



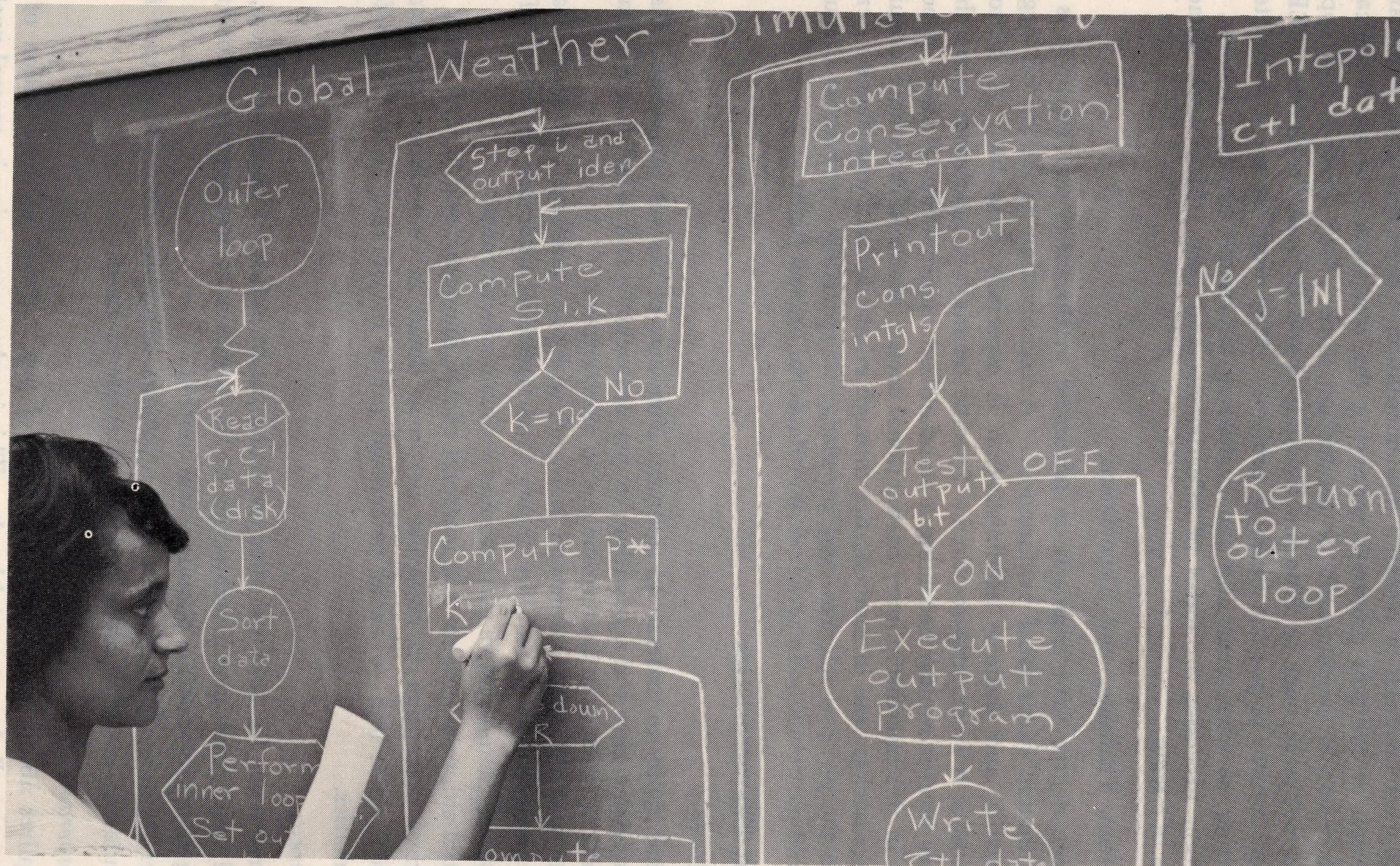
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ELECTRONICS MECHANIC, COMPUTER, TESTING CIRCUIT



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PROGRAMMER



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